PB89-116024

Technology Evaluation Report SITE Program Demonstration Test, Shirco Infrared Incineration System Peak Oil, Brandon, Florida. Volume 2

(U.S.) Environmental Protection Agency
Cincinnati, OH

Sep 88

U.S. Department of Commerce
National Technical Information Service
NTIS

PB89-116024

EPA/540/5-88/002b
September 1988

Technology Evaluation Report SITE Program Demonstration Test, Shirco Infrared Incineration System, Peak Oil, Brandon, Florida

Volume II

by

Seymour Rosenthal
Enviresponse, Incorporated
Livingston, NJ 07039

Cooperative Agreement 68-03-3255

SITE Project Manager

Howard Wall
Risk Reduction Engineering Laboratory
Cincinnati, OH 45268

Risk Reduction Engineering Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.
EPA/540/5-88/002b

2.

3. RECIPIENT'S ACCESSION NO.
PB89-116024/AS

4. TITLE AND SUBTITLE
TECHNOLOGY EVALUATION REPORT SITE PROGRAM DEMONSTRATION TEST, SHIRCO INFRARED INCINERATION SYSTEM, PEAK OIL, BRANDON, FLORIDA, Volume II

5. REPORT DATE
September 1988

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Howard O. Wall[1] and Seymour Rosenthal[2]

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
[1] Risk Reduction Engineering Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

[2] Enviresponse
Incorporated
Livingston, NJ
07039

10. PROGRAM ELEMENT NO.

11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS
Risk Reduction Engineering Laboratory - Cincinnati Ohio
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268

13. TYPE OF REPORT AND PERIOD COVERED

14. SPONSORING AGENCY CODE
EPA/600/14

15. SUPPLEMENTARY NOTES
Howard O. Wall, Project Officer - FTS (513) 684-7691 Comm: (513) 569-7881

16. ABSTRACT

A Shirco Infrared System used for a removal action at a PCB-containing oil refining waste site in Brandon, Florida (a suburb of Tampa) was evaluated. The evaluation included a determination of toxics in the material being decontaminated as well as all the effluent streams such as ash, air emissions and wastewater. These streams were analyzed for heavy metals, organics, dioxins, furans as well as NO_x, and inorganic acids. Leaching tests were performed on the ash. The results indicated that the PCB was reduced from 5 to 100 ppm to less than 1 ppm in the ash, which was the purpose of the removal action. Although research had indicated that the lead compounds in the ash would become insoluble because they would be complexed with carbon, the ash could not be considered non-leachable based on the EP toxicity tests.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT
Release to Public

19. SECURITY CLASS (This Report)
Unclassified

20. SECURITY CLASS (This page)
Unclassified

21. NO. OF PAGES
404

22. PRICE
A18 $42.95

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

ATTENTION

PORTIONS OF THIS REPORT ARE NOT LEGIBLE.
HOWEVER, IT IS THE BEST REPRODUCTION
AVAILABLE FROM THE COPY SENT TO NTIS.

NOTICE

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

VOLUME II CONTENTS*

Page

A. Operating Log Data A-1
  Unit Log Data, Operator Input A-3
  Unit Log Data, Computer Spreadsheet A-12
  Summary, Feed Tabulation Forms
    Waste Feedrate, Operator Input A-41
  Computer Graphs, Daily Waste Feedrates A-42
B. Sampling and Analytical Report B-1
  Introduction 1-1
  Presentation of Results 2-1
  Quality Assurance and Quality Control 3-1
  Trip Log 4-1
C. Quality Assurance Project Plan/Test Plan C-1
  Project Description 1-1
  Project Organization and Responsibilities . . 2-1
  Data Quality Objectives 3-1
  Sampling Program 4-1
  Laboratory Procedures/Calibrations/Quality
    Control 5-1
  Data Reduction, Validation, and Reporting . . 6-1
  Internal Quality Control Checks 7-1
  Performance and System Audits 8-1
  Data Quality Indicators 9-1
  Corrective Action 10-1
  Quality Assurance Reporting 11-1
  Project Safety 12-1
  Analysis of Anions (Fluoride, Chloride,
    Sulfite, Sulfate, and Phosphate) in
    Scrubber Liquors and Solids by Ion
    Chromatography with Modified Anion Eluent . 27-1
  Analysis of Carbonate in Scrubber Liquor,
    Scrubber Solids and Limestone by Non-
    Dispersive Infrared (NDIR) Absorption
    Spectrophotometry 44-1

---

* Volume I contains the Shirco Peak Oil facility process description, field operations documentation, performance data evaluation, summary of the S&A program, and economic analysis.

APPENDIX A

Operating Log Data

APPENDIX A

OPERATING LOG DATA

The following operating data, as referenced in Section 4.3, is included herein:

- Board-mounted and local instrument log data as inputted by Haztech's operations staff. Originals of this log data are available for reference and confirmation of input values by contacting Mr. S. Furstein, Haztech, Inc., (404) 981-9332.

- Computer spreadsheet input of above operating log data.

- A summary of the feed tabulation forms presenting waste feedrates as inputted by Haztech's operations staff.

- Computerized graphical presentation of total daily waste feedrates for each month of unit operation.

UNIT LOG DATA
OPERATOR INPUT

DATE 8/7/87 SITE NAME Peak oil SITE NUMBER

0001 STOPPED FEED FOR CARBON BURNOUT & DIST. TRAY CLEANING
0010-0116 ID VAM 0115 STARTED FEED
0355-0510 ID VAM 0550-0610 PUMPING DEMISTER
1503-1543 THERMOCOUPLE - NO FEED

		TIME	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
		INCLINED CONVEYOR HZ	51.6	51.6	51.6	51.6	51.6	51.6	51.6	51.6	51.6	51.6	51.7	51.7	51.7	51.7	51.7	0	51.7	51.7	51.7	51.7	51.7	51.7	51.7	51.7
		% FEED RATE	44	0	42	44	44	44	44	44	44	44	44	44	44	44	44	0	44	44	44	44	44	44	44	44
		RUN HOURS	2562	2563	2564	2565	2566	2567	2568	2569	2570	2571	2572	2573	2574	2575	2576	2577	2578	2579	2580	2581	2582	2583	2584	2585
PRIMARY CHAMBER	TEMP °F ZONES	A-1	1600	1330	1611	1434	1638	1691	1687	1651	1731	1701	1717	1782	1714	1699	1713	1354	1631	1625	1618	1630	1554	1554	1541	1486
		A-2	1802	1578	1772	1671	1763	1809	1764	1725	1823	1792	1841	1820	1806	1810	1806	1507	1830	1735	1722	1717	1761	1814	1688	1631
		A-3	1837	1621	1833	1765	1815	1823	1815	1791	1817	1858	1817	1817	1800	1805	1825	1574	1762	1786	1779	1738	1771	1830	1848	1768
		B-1	1765	1601	1767	1734	1756	1768	1774	1748	1765	1793	1787	1762	1771	1776	1738	1624	1790	1706	1699	1722	1705	1738	1755	1730
		B-2	1745	1590	1765	1733	1724	1733	1766	1732	1743	1734	1737	1735	1735	1760	1743	1663	1813	1727	1690	1704	1702	1733	1768	1652
		B-3	1254	1520	1291	1744	1371	1740	1727	1274	1328	1276	1282	1289	1295	1626	1276	1259	1321	1262	1380	1381	1346	1355	1410	1396
		EXHAUST	1936	1333	1767	1732	1838	1861	1824	1878	1886	1879	1810	1854	1841	1819	1836	1545	1788	1836	1846	1858	1788	1793	1819	1780
		ASH DISCH	207	155	196	208	208	207	207	210	206	209	209	210	209	209	210	193	188	210	206	209	207	210	211	210
	BLOWER DAMP. % OPEN		50	50	34	48	48	48	47	52	51	51.5	54	54	53	54	34	5	30	46	42	46	46	45	48	50
	DRAFT-IN. H₂O		.06	.09	.07	.06	.07	.01	.06	.06	.06	.06	.06	.06	.06	.05	.05	.05	.05	.05	.05	.05	.05	.04	.04	.04
	RES. TIME MIN.		19.0	18.1	19.4	17.3	19.7	19.4	20.0	19	19	19	19	19.2	19	19	19	19	19	19	19	19.0	18.9	13.9	18.0	19.1
SEC. CHAM.	TEMP °F	CHAMBER	1760	1874	1914	1878	1870	1896	1940	1878	1888	1878	1891	1891	1896	1895	1901	1805	1924	1923	1881	1903	1916	1906	1872	1849
		EXHAUST	1794	1774	1870	1857	1835	1863	1901	1845	1844	1841	1847	1843	1850	1855	1862	1757	1877	1877	1842	1863	1869	1865	1841	1843
	BLOWER DAMPER %		0	50	5	5	0	0	5	0	19	18	20	10	13	12	13	12	20	24	0	0	0	0	0	0
	DRAFT-IN. H₂O		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
SCRUBBER	% ΔP	VENTURI #1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		VENTURI #2	83	89	72	83	94	98	88	89	101	105	108	106	104	96	107	107	91	105	102	100	96	99	99	95
	TEMP °F	QUENCH #1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		QUENCH #2	183	171	183	185	185	184	184	184	182	183	183	183	184	184	184	168	183	184	184	183	183	183	183	184
	% FLOW	QUENCH #2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		QUENCH #2	65	65	63	63	62	63	63	64	64	64	63	63	63	62	66	66	64	64	64	64	64	64	64	64
		QUENCH REC. #2	118	118	118	118	118	118	118	118	118	118	118	119	118	118	118	118	118	118	118	118	118	118	118	118
		VENT. REC. #2	99	98	98	98	98	97	98	98	98	98	97	97	97	97	99	99	100	100	100	100	100	100	100	100
		CHEVP W REC	64	64	64	64	64	63	63	62	62	61	61	61	61	59	59	58	58	57	56	56	56	56	56	56
		CHEM. REC.	105	105	105	105	105	105	105	105	105	104	104	104	105	104	104	105	105	105	104	104	104	104	104	104
	pH		8.0	[illegible]	8.0	8.0	8.0	8	8	8	8.2	8.2	8.1	8.0	8.0	8.2	8.2	8.2	8.3	8.3	8.3	8.0	8.0	8.0	8.0	8.0
	LEVEL		11.5	12.5	11.2	11.5	11.5	12	11.5	11.6	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
EXH. STACK	ANAL.	OXYGEN %	5.5	13.5	5.0	5.5	5.0	5.5	5.0	5.6	5.8	5.6	5.2	5.5	4.5	5.2	5.4	9	6.5	5.8	5.2	5.5	5.0	5.0	5.5	4.5
		CARBON DIOXIDE %	10	8	10	9.5	10	9	10	10	10	10	10	10	10	10	10	7	9.5	9.5	9.5	9.0	9.0	8.5	7.5	7.5
		CARBON MONOXIDE PPM	7	9	7	6	7	6	6	6	6	5	5	5	5	5	4	4	5	5	5	7	7	7	7	7
		Stack Temp °F	180	165	183	185	179	179	180	180	179	179	179	179	185	188	188	171	178	179	179	179	181	180	179	180
	VELOCITY - FT/MIN		2400	1200	2100	2100	2300	2400	2400	2350	2400	2150	2200	2000	1900	1900	1900	700	2400	2900	2600	2250	2250	2350	2350	2300

DAY CREW:
Allen
Clump
Vogel

NIGHT CREW:
M. Solano
S. Cleary
G. Graham

Mark, P.
Mike, R.

OTHERS:

DATE 8/1/87 SITE NAME Pa.K.C. / SITE NUMBER ____________

				0000	0200	0400	0600	0800	1000	1200	1400	1600	1800	2000	2400
PRIMARY CHAMBER	HEPC ZONE 'A'	VOLTS	A	0	0	0	0	0	0	0	0	0	0	0	0
			B											0	
			C											0	
		AMPS	A											0	
			B											0	
			C											0	
	HEPC ZONE 'B'	VOLTS	A											0	
			B											0	
			C											0	
		AMPS	A											0	
			B											0	
			C											0	
	DRAFT-IN. H2O			.06	.06	.06	.06	.06	.06	.06	.10	.06	.06	-.07	-.02
	ASH QUENCH H2O		PSI	83	79	75	79	79	99	79	79	80	80	80	[illegible]
	COMB AIR		PSI	3.4	2.4	3.4	3.2	3.2	3.2	3.2	3.2	2.8	2.9	3.6	4.0
	COMB AIR		ACFM	1600	1400	1600	1550	1550	1550	1600	1600	1500	1500	1600	1500
SECONDARY CHAMBER	QUENCH	AIR	PSI	0	0	0	0	0	0	0	0	0	0	0	0
			ACFM	0	0	0	0	0	0	0	0	0	0	0	0
		WATER	PSI	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60
			GPM	0	0	0	0	0	0	0	0	0	0	0	0
	COMBUSTION AIR		PSI	3.2	4	3	3.2	3.8	11.8	4.0	3.8	5.0	3.8	4.0	4.0
			ACFM	3400	3500	3200	3500	3250	3250	3250	3000	3250	3250	3100	3400
	F.D. AIR		PSI	>20	>20	20	>20	>20	>20	>20	>20	>20	19.5	20	14.5
			ACFM	520	400	1020	420	600	400	400	1000	1000	1100	900	1100
	PROPANE X 10		PSI	10	10.5	8	11	11	11	11	9	8	8	9	8
				85	55	170	55	95	65	65	160	190	190	150	185
	CHAMBER DRAFT		IN H2O	<-.25	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<-.25	<-.25
AIR COMP.	PLANT AIR		PSI	92	95	97	95	97	96	93	96	97	97	77	95
			°F	83	83	83	83	82	91	100	98	92	80	93	85
	DISCH FILTERS OK?			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	AIR RECEIVER OK?			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
QUENCH TUBES	EMER. QUENCH H2O		PSI	78	76	72	76	76	76	77	76	77	76	74	76
	VENTURI	#1	ΔP IN.	—	—	—	—	—	—	—	—	—	—	—	—
		#2	ΔP IN.	10	19	22	18	23	23	23	21	22.5	23	21	22
SCRUBBER	CHEVRON SECTION	RECY PUMP		48	47	47	47	47	47	48	48	48	48	44	48
		WHICH PUMP		1	1	1	1	1	1	1	1	1	1	1	1
		SUMP TEMP		149	148	150	149	150	150	152	152	152	149	146	146
		ΔP IN. H2O		.65	.15	0	.05	.21	.23	.22	.22	.23	.23	.05	0
		BLOWDOWN		—	—	—	—	—	—	—	—	—	—	—	—
		DISCH FILTER		55	55	55	55	57	54	52	52	54	54	54	55
	CHEMICAL SECTION	RECYCLE	PSI	12	12	12	12	12	12	12	12	12	12	12	12
		WHICH PUMP		1	1	1	1	1	1	1	1	1	1	1	1
		SUMP TEMP		173	170	170	170	170	170	172	172	172	170	172	170
		ΔP IN. H2O		.5	1	1.4	1	1.1	1.3	1.2	1.3	1.5	1.4	1.3	1.4
	DISTRIB. PLATE	LEVEL	IN.	2"	½"	½"	½"	½	½	1"	1"	1"	1"	1"	1"
		PRESS.	PSI	0	0	0	0	0	0	0	0	0	0	0	0
	DEMISTER SEC. ΔP IN H2O			.10	.10	.10	.10	.10	.23	.23	.23	.23	.23	.10	.18
CHEMICAL MIX TANK	PUMP	PRESS	PSI	15	15	16	16	15	16	16	16	16	15	14	16
		WHICH PUMP		1	1	1	1	1	1	1	1	1	1	1	1
	TEMP		°F	124	124	124	124	125	125	130	130	130	129	122	122
EXHAUST STACK	I.D. BLOWER	BEARING OILER		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		VIBRATION		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	—
	CONDENSATE OK?			—	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	✓

MISC.	TIME	0700	1900
	B.D. POOL LEVEL OK?	X	✓
	PROPANE LEVELS N	50	72
	PROPANE LEVELS S	55	73
	DIESEL LEVEL	3/4	2½
	GASOLINE LEVEL	3/4	2½
	EMERGENCY GEN. OK?	2	2½

REMARKS:

	1100	1200	1300	1400	1500	1600	1700
KW			1600	1659	1650	1650	1600
% NaOH							
Gal NaOH	1"	1.5"	1"	1.5"	1"	.5	1"

DATE 8/2/87 SITE NAME PEAK-OIL SITE NUMBER

0135-0625 NO FEED - WORK ON SCRUBBER, FLUSH STACK
0600-0735 JD WASH
2211-2246 NO FEED - BELT PROBLEM

					TIME	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1200	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
					INCLINED CONVEYOR HZ	51.7	51.7						51.7	51.7	51.7	51.7	51.7	51.7	51.7	51.7	51.7	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.8
					% FEED RATE	44	44						40	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	42
					RUN HOURS	2586	2587						2591	2592	2593	2593	2594	2595	2596	2597	2598	2599	2600	2601	2602	2603	2604	2605	2606
PRIMARY CHAMBER	TEMP °F	ZONES	A-1			1520	1535						1524	1488	1593	1594	1508	1617	1623	1616	1600	1608	1559	1573	1595	1788	1268	1278	1461
			A-2			1634	1666						1671	1614	1663	1575	1576	1683	1897	1651	1650	1656	1611	1121	1645	1636	1551	1558	1544
			A-3			1794	1815						1760	1764	1811	1777	1731	1800	1803	1760	1737	1719	1696	1715	1774	1815	1825	1763	1838
			B-1			1740	1752						1591	1685	1864	1689	1673	1618	1624	1660	1667	1635	1635	1648	1668	1668	1727	1653	1658
			B-2			1712	1727						1666	1742	1669	1675	1747	1705	1714	1663	1672	1636	1671	1652	1665	1692	1717	1708	1712
			B-3			1398	1405						1335	1448	1379	1381	1376	1408	1403	1488	1474	1542	1499	1462	1566	1436	1603	1494	1335
		EXHAUST				1835	1853						1800	1810	1847	1909	1819	1933	1906	1918	1905	1918	1901	1846	1940	1772	1653	1651	1674
		ASH DISCH				210	210						209	210	210	211	211	211	211	211	208	208	208	210	209	209	209	209	204
	BLOWER DAMP. % OPEN					50	50						10	20	30	40	20	24	24	26	23	15	16	17	41	43	39	39	30
	DRAFT-IN. H₂O					.04	.05						.03	.05	.05	.05	.05	.05	.06	.06	.05	.06	.05	.05	.04	.05	.05	.04	.06
	RES. TIME MIN.					19.0	17.9						18.7	18.9	19	18.6	19.0	18.8	18.8	18.8	18.7	19	19	19.0	18.7	19.5	20.3	18.4	18.5
SEC. CHAM.	TEMP °F	CHAMBER				1868	1879						1875	1931	1905	1878	1845	1967	1853	1839	1904	1877	1902	1826	1856	1905	1913	1871	1901
		EXHAUST				1823	1841						1799	1883	1850	1835	1799	1829	1811	1878	1867	1828	1840	1830	1810	1848	1862	1835	1851
	BLOWER DAMPER %					0	0						0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0
	DRAFT-IN. H₂O					—	—						—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SCRUBBER	% ΔP	VENTURI #1				—	—						—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		VENTURI #2				92	93						117	86	93	98	92	113	106	109	98	94	106	107	105	101	102	99	48
	TEMP °F	QUENCH #1				—	—						—	—	—	—	—					—	—	—	—	—	—	—	—
		QUENCH #2				184	184						184	175	201	197	192	195	188	187	194	189	189	189	198	203	207	206	196
	% FLOW	QUENCH H₂O #1				—	—						—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		QUENCH H₂O #2				64	64						66	66	65	65	66	65	66	66	66	64	64	64	65	65	65	65	65
		QUENCH REC. #2				118	118						118	118	118	118	118	118	118	118	118	118	118	118	115	118	118	118	119
		VENT. REC. #2				100	100						95	95	96	96	96	96	96	96	96	88	87	86	85	85	85	85	85
		CHEVP W REC				55	55						60	61	61	60	60	60	60	60	60	57	56	56	54	54	57	57	57
		CHEM. RECY.				104	104						90	89	89	89	90	90	90	40	90	88	86	89	87	87	87	87	87
	pH					8.0	8.0						9.5	9.5	9.8	9.8	9.0	9.0	9.0	8.6	8.6	8.6	8.5	8.3	8.0	8.0	7.2	8.0	8.0
	LEVEL					11.5	11.5						11.5	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	12	11.5	11.5	11.5	11.5	11.5	11.5	11.5
EXH. STACK	ANAL.	OXYGEN %				5.0	5.5						5.0	5.5	5.0	5.6	6	5.5	4.5	5.	5.	5.0	5.0	4.5	5.5	5.0	5.0	5.0	5.0
		CARBON DIOXIDE %				7.0	6.5						4	8	7	7	8.5	8.5	8.7	7.5	9	7.5	9.5	8.5	9.5	10	10	9.5	9.5
		CARBON MONOXIDE PPM				7	7						3	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7
		Stack Temp °F				179	180						188	190	184	190	187	188	187	181	187	188	186	186	179	179	180	180	181
	VELOCITY-FT/MIN					2300	2300						1750	1750	2050	2100	2000	2100	1400	1800	[illegible]	1200	1400	1400	2100	2500	2100	2300	1900

DAY CREW:
Allen
Saegle
Vogel
Camp

NIGHT CREW:
Mike Solano
Scott Cleary
Glenn Graham

Mark, P.
Mike, F.

OTHERS:

DATE 8/2/87 SITE NAME ______ SITE NUMBER ______

TIME				0000	0200	0400	0600	0800	1000	1200	1400	1600	1800	2000	2400
RIMARY HAMBER	HEPC ZONE 'A'	VOLTS	A					5'	0	0	160	160	155		
			B								150	150	145		
			C								175	170	175		
		AMPS	A								600	500	600		
			B								595	490	540		
			C								790	740	780		
	HEPC ZONE 'B'	VOLTS	A								0	0	0		
			B												
			C												
		AMPS	A												
			B												
			C												
	DRAFT - IN. H2O							.06	.05	.06	.06	.07	.06		
	ASH QUENCH H2O PSI							84	84	82	80	80	80		
	COMB AIR PSI							2.2	2.6	1.2	1.2	1.4	1.1		
	COMB AIR ACFM							1200	1500	1200	1100	1100	1000		
ECONDARY HAMBER	QUENCH	AIR	PSI					0	0	0	0	0	0		
			ACFM					0	0	0	0	0	0		
		WATER	PSI					260	260	260	260	260	260		
			GPM					0	0	0	0	0	0		
	COMBUSTION AIR		PSI					5.8	5.8	9.0	9.0	9.0	10.0		
			ACFM					3000	3000	3500	3500	3500	2800		
	F.D. AIR		PSI					19.5	19.5	20	20	20	20		
			ACFM					1250	1100	1000	650	940	400		
	PROPANE X 10		PSI					8	8	9.5	11	10	10		
								180	185	180	105	115	65		
	CHAMBER DRAFT		IN H2O					.20	.25	.25	.25	.25	.15		
AIR OMP.	PLANT AIR		PSI					92	94	93	90	92	96		
			°F					89	92	100	101	110	90		
	DISCH FILTERS OK?							✓	✓	✓	✓	✓	✓		
	AIR RECEIVER OK?							✓	✓	✓	✓	✓	✓		
QUENCH TUBES	EMER. QUENCH H2O PSI							80	79	69	76	77	77		
	VENTURI	#1	ΔP IN. H2O					20	22	23	23	23	24		
		#2	ΔP IN. H2O												
CRUBBER	CHEVRON SECTION	RECY PUMP PSI						50	50	49	48	49	49		
		WHICH PUMP?						1	1	1	1	1	1		
		SUMP TEMP °F						150	152	153	153	153	153		
		ΔP IN. H2O						.25	.24	.25	.24	.23	.22		
		BLOWDOWN GPM						—	—	—	—	—	—		
		DISCH FILTER						52	54	54	52	52	52		
	CHEMICAL SECTION	RECYCLE PSI						9	9	9	9	9	9		
		WHICH PUMP?						1	1	1	1	1	1		
		SUMP TEMP °F						170	170	170	170	170	170		
		ΔP IN. H2O						1.2	1.2	.5	.5	.5	.5		
	DISTRIB. PLATE	LEVEL IN.						0	0	0	0	0	0		
		PRESS. PSI						0	0	0	0	0	0		
	DEMISTER SEC. ΔP IN H2O							.25	.26	.22	.22	.23	.23		
HEMICAL MIX TANK	PUMP	PRESS PSI						11	0	16	16	16	10		
		WHICH PUMP?						1	—	1	1	1	1		
	TEMP °F							119	119	120	121	121	122		
XHAUST STACK	I.D. BLOWER	BEARING OILER						✓	✓	✓	✓	✓			
		VIBRATION						✓	✓	✓	✓	✓			
	CONDENSATE OK?														

			0700	1900
MISC.	TIME		0700	1900
	B.D. POOL LEVEL OK?		✓	
	PROPANE LEVELS	N	55	85
		S	50	95
	DIESEL LEVEL		1/2	
	GASOLINE LEVEL		1/2	
	EMERGENCY GEN. OK?		✓	

	0800	1000	1200	1400	1600	1800
KW	1530			1614	1615	1616
% Noc	[illegible]					
Gal. Nool		.25"	1.5"	1.25	.5"	.5"

8/3/87

0352-0520 ID WASH
0352-0530 STACK WASH

1600 CLEANED FILTERS CHEV. RECYC. PUMP
1720 FEED LOW BTU-CUT PRIM. AIR 45→37%

		TIME	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100
		~~INC~~LINED CONVEYOR HZ	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8
		% FEED RATE	45	48	48	48	48	48	48	45	45	45	45	45
		RUN HOURS	2607	2608	2609	2610	2611	2612	2613	2614	2615	2616	2618	2618
PRIMARY CHAMBER	TEMP °F ZONES	A-1	1386	1388	1379	1406	1640	1567	1648	1614	1657	1668	1631	1635
		A-2	1676	1664	1735	1699	1712	1702	1721	1738	1657	1749	1696	1700
		A-3	1657	1814	1727	1751	1761	1808	1802	1847	1714	1707	1666	1658
		B-1	1754	1757	1805	1831	1789	1821	1789	1782	1708	1686	1662	1636
		B-2	1740	1718	1744	1725	1741	1733	1727	1682	1623	1696	1698	1691
		B-3	1380	1337	1533	1293	1770	1344	1240	1208	1268	1363	1423	1507
	TEMP °F	EXHAUST	1727	1734	1743	1900	1961	1928	1999	1935	1976	1909	1926	1952
		ASH DISCH	210	210	209	209	209	207	207	211	211	211	211	211
		BLOWER DAMP. % OPEN	40	43	50	49	51	51	51	51	48	48	48	50
		DRAFT-IN. H2O	.06	.06	.06	.06	.06	.06	.05	105	.05	.05	.05	.04
		RES. TIME MIN.	19.6	17.3	18.9	15.6	16.6	17.7	16.6	17.2	17.3	17	17	18.6
SEC. CHAM.	TEMP °F	CHAMBER	1875	1878	1943	1854	1799	1882	1873	1901	1907	1909	1895	1915
		EXHAUST	1843	1834	1886	1818	1800	1833	1829	1860	1862	1815	1860	1866
		BLOWER DAMPER %	[illegible]	0	55	0	0	15	0	52	48	0	0	0
		DRAFT-IN. H2O	—	—	—	—	—	—	—	—	—	—	—	—
SCRUBBER	% ΔP	VENTURI #1	—	—	—	—	—	—	—	—	—	—	—	—
		VENTURI #2	104	103	90	77	87	89	64	94	104	98	101	101
	TEMP °F	QUENCH #1	—	—	—	—	—	—	—	—	—	—	—	—
		QUENCH #2	203	210	210	212	212	211	207	200	186	190	194	197
	% FLOW	QUENCH H2O #1	—	—	—	—	—	—	—	—	—	—	—	—
		QUENCH H2O #2	65	65	65	65	65	65	65	65	65	65	65	65
		QUENCH REC. #2	111	112	112	112	112	112	112	112	108	108	106	103
		VENT. REC. #2	82	82	82	82	82	82	82	82	79	79	78	78
		CHEVRON REC.	57	57	57	57	57	57	57	57	55	54	53	53
		CHEM. RECY.	86	86	86	86	86	86	86	86	86	85	85	86
		pH	8.0	7.5	7.5	8.0	8.0	8.0	8.0	7	7.5	8.5	8.5	8.4
		LEVEL	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
EXH. STACK	ANAL.	OXYGEN %	5.5	5.0	4.5	5.5	5.5	4.5	5.0	5.	5.0	5.0	5.0	5.2
		CARBON DIOXIDE %	9.5	9.5	10	9.0	9.5	9.5	9.5	9.5	9.5	9.5	9.5	10
		CARBON MONOXIDE %	7	7	7	7	7	7	7	7	7	7	7	7
		H ~~[illegible]~~ STACK [illegible]	180	180	181	185	179	180	180	181	181	186	186	186
		VELOCITY-FT/MIN	2150	2100	2300	2100	2200	2100	2200	2300	2100	1900	1700	1500

		TIME	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
		~~INC~~LINED CONVEYOR HZ	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8
		% FEED RATE	45	45	45	45	45	45	45	45	45	45	45	45
		RUN HOURS	2619	2620	2621	2622	2623	2624	2625	2626	2627	2628	2629	2630
PRIMARY CHAMBER	TEMP °F ZONES	A-1	1710	1694	1674	1624	1671	1599	1495	1520	1536	1568	1364	1400
		A-2	1712	1720	1719	1681	1667	1654	1606	1650	1649	1717	1635	1634
		A-3	1748	1765	1788	1766	1743	1726	1719	1753	1741	1794	1773	1718
		B-1	1712	1656	1707	1706	1712	1682	1646	1624	1675	1666	1639	1615
		B-2	1647	1540	1610	1631	1656	1596	1659	1620	1565	1584	1571	1563
		B-3	1374	1250	1313	1312	1349	1285	1335	1744	1283	1432	1359	1447
	TEMP °F	EXHAUST	2032	2034	1993	1939	1913	1892	1870	1871	1899	2014	1971	1913
		ASH DISCH	211	210	210	211	211	210	210	209	209	209	211	209
		BLOWER DAMP. % OPEN	54	50	50	48	48	48	21	21	21	34	40	40
		DRAFT-IN. H2O	.05	.05	.05	.05	.06	.06	.06	.06	.05	.04	.04	.05
		RES. TIME MIN.	18	18	17.6	19	19	19	19	18.4	18.1	18.5	18.6	19.1
SEC. CHAM.	TEMP °F	CHAMBER	1922	1906	1872	1921	1923	1854	1880	1890	1867	1892	1895	1873
		EXHAUST	1876	1858	1844	1874	1876	1816	1855	1840	1823	1848	1857	1830
		BLOWER DAMPER %	0	0	0	0	0	0	0	0	0	0	0	0
		DRAFT-IN. H2O	—	—	—	—	—	—	—	—	—	—	—	—
SCRUBBER	% ΔP	VENTURI #1	—	—	—	—	—	—	—	—	—	—	—	—
		VENTURI #2	109	100	111	106	66	100	98	102	94	98	93	96
	TEMP °F	QUENCH #1	—	—	—	—	—	—	—	—	—	—	—	—
		QUENCH #2	201	212	206	210	200	198	192	194	191	190	194	193
	% FLOW	QUENCH H2O #1	—	—	—	—	—	—	—	—	—	—	—	—
		QUENCH H2O #2	65	65	66	65	65	65	64	64	64	64	64	64
		QUENCH REC. #2	103	102	101	98	118	118	118	118	118	118	118	118
		VENT. REC. #2	77	77	76	73	100	99	99	98	98	98	98	98
		CHEVRON REC.	52	51	151	49	60	65	64	63	63	63	63	63
		CHEM. RECY.	86	86	86	86	86	103	102	103	103	103	103	103
		pH	8.4	8.2	8.2	8.3	8.5	8.2	8.2	8.0	8.0	8.0	8.0	8.0
		LEVEL	11.5	11.5	11.5	11.5	11.5	11.5	13.6	11.5	11.5	12.4	12	11.5
EXH. STACK	ANAL.	OXYGEN %	5.4	5.0	5.2	5.2	5.0	5.2	5.2	5.0	5.5	6.0	5.5	6.0
		CARBON DIOXIDE %	10	10	10	9.5	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.5
		CARBON MONOXIDE %	8	7	7	7	7	7	6	6	7	7	7	7
		H ~~[illegible]~~ STACK [illegible]	181	180	180	187	186	185	188	186	185	183	186	186
		VELOCITY-FT/MIN	1700	1540	1700	1400	1400	1900	1600	1500	1400	1650	1150	1700

DAY CREW:
Allen
Camp
Sasla
Carpenter
(part-time

NIGHT CREW:
M. SOLANA
S. CLEARY
G. GRAHAM

MARK, P.
MIKE, R.

OTHERS:

DATE 8-3-87 SITE NAME Peak Oil SITE NUMBER ___________

			TIME	0000	0200	0400	0600	0800	1000	1200	1400	1600	1800	2000	2400
IMARY AMBER	HEPC ZONE 'A'	VOLTS	A		0	0	0			0	0	0	70	105	0
			B		|	|	|			|	|	|	90	105	|
			C		|	|	|			|	|	|	150	165	|
		AMPS	A		|	|	|			|	|	|	350	410	|
			B		|	|	|			|	|	|	375	420	|
			C		|	|	|			|	|	|	675	700	|
	HEPC ZONE 'B'	VOLTS	A		|	|	|			|	|	|	0	0	|
			B		|	|	|			|	|	|	0	0	|
			C		|	|	|			|	|	|	0	0	|
		AMPS	A		|	|	|			|	|	|	0	0	|
			B		|	|	|			|	|	|	0	0	|
			C		|	|	|			|	|	|	0	0	|
	DRAFT-IN. H₂O				.06	.06	-.06	.06		.06	.05	.05	.05	-.06	-.05
	ASH QUENCH H₂O PSI				82	72	82	82		82	82	82	81	81	81
	COMB AIR PSI				3.6	3.4	3.4	2.4		3	2.8	2.8	1.1	1.1	1.0
	COMB AIR ACFM				1550	1600	1700	1500		1750	1600	1500	1000	1000	1000
CONDARY HAMBER	QUENCH	AIR	PSI		0	0	0	—							
			ACFM		0	0	0	—							
		WATER	PSI		>60	>60	>60	>60							
			GPM		0	0	0	0							
	COMBUSTION AIR		PSI		>10	8.2	4.0	8.8		8	8	8	8.3	8.2	8.0
			ACFM		3800	3600	3600	3800		3600	3800	3800	3800	2800	3800
	F.D. AIR		PSI		>20	19.5	20	19.5		20	19.5	19.5	19.5	19.5	19.5
			ACFM		660	1040	1000	1050		1050	1000	1000	1100	1400	1400
	PROPANE X 10		PSI		10.5	8	9	8		4.5	4.8	4.8	4.8	8.0	8.0
					100	180	155	185		190	175	185	185	183	185
	CHAMBER DRAFT		IN H₂O		<.25	<.25	<.25	<.25		<.25	<.25	<.25	.23	<.25	.25
IR	PLANT AIR		PSI		92	92	82	692		92	92	90	90	92	95
			°F		85	85	83	95		89	90	96	94	97	95
MP.	DISCH FILTERS OK?				✓	✓	✓	—							
	AIR RECEIVER OK?				✓	✓	✓	—							
QUENCH UBES	EMER. QUENCH H₂O PSI				78	69	78	78		77	78	79	77	76	78
	VENTURI	#1	ΔP IN H₂O		—	—	—	—							
		#2	ΔP IN H₂O		18	18	17	32		24	26	31	20	21.5	
RUBBER	CHEVRON SECTION	RECY PUMP PSI			48	48	44	48		50	50	48	48	48	48
		WHICH PUMP?			1	1	1	1		1	1	1	1	1	1
		SUMP TEMP °F			151	151	152	152		151	151	152	151	152	150
		ΔP IN. H₂O			.10	0	.10	0		0	.10	.05	.25	0	.25
		BLOWDOWN GPM			—	—	—	—		10					
		DISCH FILTER			56	56	56	55		OK	OK	✓	✓	55	58
	CHEMICAL SECTION	RECYCLE PSI			8	8	8	8		8	9	9	11	11	11
		WHICH PUMP?			1	1	1	1		1	1	1	1	1	1
		SUMP TEMP °F			170	170	172	122		172	173	172	170	172	[illegible]
		ΔP IN. H₂O			.3	0	0	0		0	0	0	0	0	0
	DISTRIB. PLATE	LEVEL IN.			0	0	0	0		0	0	0	1/4-1/2	1/4-1/2	[illegible]
		PRESS. PSI			0	0	0	0		0	0	0	0	0	0
	DEMISTER SEC ΔP IN H₂O				.30	.25	.25	.25		.27	.26	.25	.24	.2	.25
HEMICAL MIX TANK	PUMP	PRESS PSI			16	16	16	16		16	15	18	18	15	15
		WHICH PUMP?			1	1	1	1		1	1	1	1	1	1
	TEMP °F				122	122	122	122				✓	✓	120	128
XHAUST STACK	I.D. BLOWER	BEARING OILER			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
		VIBRATION			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
	CONDENSATE OK?				✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

MISC.		TIME	0700	1900									
	B.D. POOL LEVEL OK?		✓	✓					30	80			
	PROPANE LEVELS	N	40	22					30	80			
		S	40	70									
	DIESEL LEVEL		1/2	≈1/2									
	GASOLINE LEVEL		4/4	3/4									
	EMERGENCY GEN. OK?		2/3	2/3									
	KW				0608	0608	608	0608	0608	0608	0608		
	% Noc												
	Gal. Nool												

8/4/87

0410-0600 ID/STACK WASH

1200 PROBLEM @ VENTURI DAMPER TO MAINTAIN DP 22"

	TIME	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100
	INCLINED CONVEYOR HZ	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8
	% FEED RATE	45	45	45	45	45	45	45	45	45	45	45	45
	RUN HOURS	2631	2632	2633	2634	2635	2636	2637	2638	2639	2640	2641	2642
PRIMARY CHAMBER	TEMP °F ZONES A-1	1516	1451	1457	1434	1411	1432	1388	1462	1461	1445	1382	1417
	A-2	1689	1648	1664	1666	1658	1677	1625	1620	1650	1634	1585	1598
	A-3	1740	1789	1788	1713	1755	1809	1780	1768	1736	1736	1680	1679
	B-1	1509	1594	1605	1615	1631	1696	1647	1671	1664	1613	1642	1632
	B-2	1462	1619	1573	1558	1577	1653	1572	1605	1637	1595	1577	1605
	B-3	1464	1615	1650	1438	1543	1685	1651	1558	1536	1147	1097	1119
	EXHAUST	2083	1937	1987	2011	1980	1939	2005	2047	1926	1958	1888	1879
	ASH DISCH	206	210	210	206	210	210	209	207	209	205	205	202
	BLOWER DAMP. % OPEN	45	40	40	40	42	45	45	45	40	31	24	22
	DRAFT-IN. H2O	.05	.05	.05	.06	.05	.06	.05	.06	.06	.06	.06	.05
	RES. TIME MIN.	17.9	18.6	18.6	18.8	19.3	18.8	19.0	18.4	19	19	19	19
SEC. CHAM.	TEMP °F CHAMBER	1912	1935	1932	1866	1922	1920	1923	1913	1923	1872	1884	1913
	EXHAUST	1850	1873	1874	1837	1870	1867	1873	1873	1898	1851	1834	1860
	BLOWER DAMPER %	0	45	20	0	0	30	20	30	0	0	0	0
	DRAFT-IN. H2O	—	—	—	—	—	—	—	—	—	—	—	—
SCRUBBER	% ΔP VENTURI #1	—	—	—	—	—	—	—	—	—	—	—	—
	VENTURI #2	94	102	65	75	79	86	85	72	104	100	112	92
	TEMP °F QUENCH #1	—	—	—	—	—	—	—	—	—	—	—	—
	QUENCH #2	194	189	190	189	189	194	192	191	191	190	189	190
	% FLOW QUENCH H2O #1	05	—	—	—	—	—	—	—	—	—	—	—
	QUENCH H2O #2	65	65	65	65	65	65	64	64	63	65	65	65
	QUENCH REC. #2	[illegible]	118	118	118	118	118	117	116	118	118	118	118
	VENT. REC. #2	[illegible]	98	98	98	98	98	97	96	99	98	99	97
	CHEVRON REC.	60	60	60	60	60	60	55	53	54	53	53	53
	CHEM. RECY.	102	102	102	102	102	102	102	102	102	102	97	96
	pH	8.0	7.5	8.0	8.0	8.0	7.1	7.7	7.7	8.0	8.0	8.0	8.0
	LEVEL	12	15	11.0	10.8	12.0	10.5	12.4	10.6	11.0	11.5	11.5	11.5
EXH STACK	ANAL. OXYGEN %	5.0	5.5	5.0	4.5	5.0	5.0	5.0	5.0	5.2	5.5	5.5	5.2
	CARBON DIOXIDE %	9.0	9.5	9.0	9.5	9.0	9.0	8.5	8.0	9.0	9.0	9.0	9.5
	CARBON MONOXIDE %	7	7	7	6	7	6	7	7	7	7	7	7
	HYDROCARBON PPM	186	185	185	182	183	180	190	186	184	186	186	186
	VELOCITY - FT/MIN	1700	1500	1800	1600	1850	1950	1850	1700	2000	1650	1650	1450

	TIME	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
	INCLINED CONVEYOR HZ	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8
	% FEED RATE	45	45	45	45	45	45	45	45	45	45	45	45
	RUN HOURS	2643	2644	2645	2646	2647	2648	2649	2650	2651	2652	2653	2654
PRIMARY CHAMBER	TEMP °F ZONES A-1	1407	1439	2645	1481	1513	1542	1508	1541	1555	1546	1519	1524
	A-2	1610	1581	1447	1604	1627	1711	1689	1710	1684	1644	1675	1664
	A-3	1669	1659	1616	1647	1686	1783	1716	1708	1763	1800	1731	1704
	B-1	1635	1588	1669	1572	1589	1618	1599	1753	1654	1648	1591	1574
	B-2	1553	1612	1591	1587	1622	1566	1616	1544	1619	1617	1597	1582
	B-3	1100	1321	1629	1472	1586	1334	1246	[illegible]	1199	1230	1197	1119
	EXHAUST	1920	1918	1264	1867	1892	1916	1930	1847	1740	1738	1794	1837
	ASH DISCH	203	206	1265 205	209	209	204	210	207	202	204	208	207
	BLOWER DAMP. % OPEN	23	16	16	17	27	22	22	12	12	12	12	12
	DRAFT-IN. H2O	.05	04	.05	.04	.04	.04	.05	.05	.05	.05	.04	.04
	RES. TIME MIN.	19	19	19	19	19	19	19	19.2	19.0	19.1	18.9	18.5
SEC. CHAM.	TEMP °F CHAMBER	1849	1924	1907	1923	1901	1920	1843	1893	1942	1924	1912	1869
	EXHAUST	1818	1864	1861	1851	1857	1883	1805	1840	1888	1872	1861	1842
	BLOWER DAMPER %	0	0	0	0	15	0	0	0	40	30	0	0
	DRAFT-IN. H2O	—	—	—	—	—	—	—	—	—	—	—	—
SCRUBBER	% ΔP VENTURI #1	—	—	—	—	—	—	—	—	—	—	—	—
	VENTURI #2	92	116	111	117	109	110	110	100	103	99	99	99
	TEMP °F QUENCH #1	—	—	—	—	—	—	—	—	—	—	—	—
	QUENCH #2	190	188	189	186	188	184	184	185	186	186	186	185
	% FLOW QUENCH H2O #1	—	—	—	—	—	—	—	—	—	—	—	—
	QUENCH H2O #2	65	65	65	65	65	65	65	65	65	65	65	65
	QUENCH REC. #2	118	118	118	118	118	118	118	118	118	118	118	118
	VENT. REC. #2	100	99	99	99	100	100	100	100	100	100	100	100
	CHEVRON REC.	53	53	53	53	53	52	52	52	52	52	52	52
	CHEM. RECY.	97	97	97	97	97	97	97	97	97	97	97	97
	pH	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
	LEVEL	11.5	11.5	11.5	11.5	11.5	11.5	11.6	11.5	11.5	11.5	11.5	11.5
EXH STACK	ANAL. OXYGEN %	5.0	5.3	5.3	5.0	5.0	5.0	6.0	5.5	5.0	5.5	5.0	5.5
	CARBON DIOXIDE %	9.0	9.5	9.3	10.0	9.0	9.5	8.5	9.0	9.5	9.5	9.0	9.0
	CARBON MONOXIDE %	7	7	7	7	7	7	7	7	7	7	6	7
	HYDROCARBON PPM	186	185	187	185	187	185	184	185	185	185	187	186
	VELOCITY - FT/MIN	1500	1500	1400	1600	2000	1750	1650	1550	1500	1700	1500	1500

DAY CREW:
Allen
Saegla
Camp

NIGHT CREW:
M. Solano
S. Cleary
G. Graham

Mack, P.
Mike, R.

OTHERS:

DATE 8/4/87 SITE NAME ______ SITE NUMBER ______

			TIME	0000	0200	0400	0600	0800	1000	1200	1400	1600	1800	2000	2200
RIMARY HAMBER	HEPC ZONE 'A'	VOLTS	A	170	[illegible]	170	0	75	[illegible]	10	125	80	110	0	140
			B	170	150	170		85	70	70	115	95	115		130
			C	175	175	175		145	80	85	160	130	125		175
		AMPS	A	640	640	660		320	300	300	400	320	360		560
			B	645	600	620		360	320	320	460	400	380		520
			C	740	760	670		660	440	460	720	480	440		740
	HEPC ZONE 'B'	VOLTS	A	0	0	0									0
			B	0	0	0									
			C	0	0	0									
		AMPS	A	0	0	0									
			B	0	0	0									
			C	0	0	0									
	DRAFT-IN. H₂O			-.05	-.06	-.07	-.05	-.07	.05	.05	.05	.05	.05	.05	.04
	ASH QUENCH H₂O PSI			75	75	68	80	78	78	78	78	78	78	85	83
	COMB AIR PSI			4.8	4.6	4.4	4.0	1	2.4	0.8	1.2	1.4	.8	.6	.6
	COMB AIR ACFM			1250	1250	1250	1200	1250	1300	1000	1250	1300	1100	1000	1000
ECONDARY HAMBER	QUENCH	AIR	PSI	0	0	0	0	0	0	0	0	0	0	0	0
			ACFM	0	0	0	0	0	0	0	0	0	0	0	0
		WATER	PSI	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60	>60
			GPM	0	0	0	0	0	0	0	0	0	0	0	0
	COMBUSTION AIR		PSI	9.2	8.4	8.4	>10	8	8.2	6.8	8.4	8	8	9.8	8
			ACFM	3000	3100	3200	3200	3200	3300	3100	2300	2600	2300	3300	<2300
	F.D. AIR		PSI	19.5	19.5	>20	>20	>20	>20	>20	>20	>20	>20	>20	19.5
			ACFM	1300	1050	420	550	1000	900	1000	840	900	1000	760	1020
	PROPANE X 10		PSI	8	8	11	10	8	8	8	9	9	8	10	8.5
				145	185	65	120	185	125	185	145	155	185	125	170
	CHAMBER DRAFT		IN H₂O	<-.25	<-.25	<-.25	<-.25	<-.25	<-.25	.25	<-.25	<-.25	<-.25	<-.25	.23
AIR	PLANT AIR		PSI	95	95	95	95	95	95	95	95	95	95	98	90
			°F	95	95	93	87	87	87	90	92	92	92	88	88
DMP.	DISCH FILTERS OK?			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	AIR RECEIVER OK?			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
QUENCH TUBES	EMER. QUENCH H₂O PSI			72	75	75	76	76	76	76	76	76	76	80	80
	VENTURI	#1	ΔP IN. H₂O	—											
		#2	ΔP IN. H₂O	14	17	16	18	22	22	22	22	20	22	22	22
CRUBBER	CHEVRON SECTION	RECY PUMP PSI		48	44	48	48	48	48	48	48	48	48	48	48
		WHICH PUMP?		1	1	1	1	1	1	1	1	1	1	1	1
		SUMP TEMP °F		152	150	150	150	150	150	150	150	152	152	152	152
		ΔP IN. H₂O		.30	.05	.20	.10	.25	.25	.25	0	.25	.25	.30	.05
		BLOWDOWN GPM		80	70	50	30	20	25	25	30	30	30	15	20
		DISCH FILTER		55	55	55	55	55	55	55	55	57	57	57	57
	CHEMICAL SECTION	RECYCLE PSI		11	11	11	11	11	11	11	11	11	11	11	11
		WHICH PUMP?		1	1	1	1	1	1	1	1	1	1	1	1
		SUMP TEMP °F		172	172	172	172	172	172	172	172	174	124	170	170
		ΔP IN. H₂O		0	0	0	0	0	0	0	0	0	0	0	0
	DISTRIB. PLATE	LEVEL IN.		1/4-1/2	1/4-1/2	1/4-1/2	1/4-1/2	1/4	1/4	1/4-1/2	1/2-1	1/2-1	1/2-1	1/2-1"	1/2"
		PRESS. PSI		0	0	0	0	0	0	0	0	0	0	0	0
	DEMISTER SEC ΔP IN H₂O			.30	.25	.20	.25	.25	.30	.25	.20	.25	.30	.20	.20
HEMICAL MIX TANK	PUMP	PRESS PSI		18	18	18	18	18	18	18	18	18	18	18	18
		WHICH PUMP?		1	1	1	1	1	1	1	1	1	1	1	1
	TEMP °F			122	122	122	122	122	122	122	120	120	122	118	118
XHAUST STACK	I.D. BLOWER	BEARING OILER		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		VIBRATION		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CONDENSATE OK?			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MISC.	TIME			0700	1900										
	B.D. POOL LEVEL OK?				✓										
	PROPANE LEVELS	N		37	80										
		S		37	65										
	DIESEL LEVEL			✓	F										
	GASOLINE LEVEL			✓	F										
	EMERGENCY GEN. OK?			✓	F										
	KW							0.614	0.614	0.614	0614		0615	0626	0626
	% Noc														
	Gal Nool							625	625						

UNIT LOG DATA
COMPUTER SPREADSHEET

AUGUST 1, 1987

Time			00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00
Feedrate,%			44.00	0.00	42.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
Run Hours			2562.00	2563.00	2564.00	2565.00	2566.00	2567.00	2568.00	2569.00	2570.00	2571.00	2572.00	2573.00	2574.00
Primary	Temp.,F Zones	A1	1800.00	1330.00	1611.00	1534.00	1638.00	1691.00	1687.00	1651.00	1731.00	1701.00	1717.00	1702.00	1714.00
Chamber		A2	1802.00	1578.00	1732.00	1671.00	1763.00	1809.00	1764.00	1725.00	1823.00	1792.00	1841.00	1820.00	1806.00
		A3	1837.00	1621.00	1833.00	1765.00	1815.00	1833.00	1815.00	1791.00	1817.00	1858.00	1817.00	1819.00	1800.00
		B1	1789.00	1601.00	1767.00	1734.00	1756.00	1768.00	1774.00	1748.00	1765.00	1793.00	1787.00	1762.00	1771.00
		B2	1745.00	1590.00	1765.00	1733.00	1734.00	1733.00	1768.00	1732.00	1743.00	1724.00	1737.00	1735.00	1735.00
		B3	1284.00	1520.00	1291.00	1344.00	1371.00	1340.00	1327.00	1274.00	1328.00	1276.00	1282.00	1289.00	1295.00
		Exhaust	1936.00	1323.00	1767.00	1732.00	1838.00	1861.00	1824.00	1878.00	1886.00	1879.00	1810.00	1854.00	1841.00
		Ash Discharge	207.00	155.00	196.00	208.00	208.00	207.00	207.00	210.00	206.00	209.00	209.00	210.00	209.00
	Blower Damper,% Open		50.00	50.00	34.00	48.00	48.00	48.00	47.00	52.00	51.00	51.50	54.00	54.00	53.00
	Draft,in. H2O		0.06	0.09	0.07	0.06	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	Residence Time,min.		19.00	18.10	19.40	17.30	19.70	19.90	20.00	19.00	19.00	19.00	19.00	19.20	19.00
Secondary	Temp.,F	Chamber	1780.00	1834.00	1914.00	1878.00	1876.00	1896.00	1940.00	1878.00	1888.00	1878.00	1891.00	1881.00	1896.00
Chamber		Exhaust	1794.00	1774.00	1870.00	1857.00	1835.00	1863.00	1901.00	1845.00	1844.00	1841.00	1847.00	1843.00	1850.00
	Blower Damper,% Open		0.00	50.00	5.00	5.00	0.00	0.00	5.00	0.00	19.00	10.00	20.00	10.00	20.00
	Draft,in. H2O														
	Delta P,%	Venturi 1													
Scrubber		Venturi 2	83.00	89.00	72.00	83.00	94.00	98.00	88.00	89.00	101.00	105.00	108.00	106.00	104.00
	Temp.,F	Quench 1													
		Quench 2	183.00	171.00	183.00	185.00	185.00	184.00	184.00	184.00	182.00	183.00	183.00	183.00	184.00
	Flow,%	Quench H2O 1													
		Quench H2O 2	65.00	65.00	63.00	63.00	62.00	63.00	63.00	64.00	64.00	64.00	63.00	63.00	63.00
		Quench Recyc.	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00
		Venturi Recyc.	98.00	98.00	98.00	98.00	98.00	98.00	98.00	98.00	98.00	98.00	97.00	97.00	97.00
		Chevron Recyc.	64.00	64.00	64.00	64.00	63.00	63.00	62.00	62.00	61.00	61.00	61.00	61.00	59.00
		Chemical Recyc.	105.00	105.00	105.00	105.00	105.00	105.00	105.00	105.00	104.00	104.00	104.00	105.00	104.00
	pH		8.00	7.00	8.00	8.00	8.00	8.00	8.00	8.00	8.20	8.20	8.10	8.00	8.00
	Level		11.50	12.50	11.20	11.50	11.50	12.00	11.50	11.60	11.50	11.50	11.50	11.50	11.50
Stack		O2,%	5.50	13.50	5.00	5.50	5.00	5.50	5.00	5.60	5.80	5.60	5.20	5.50	4.50
Exhaust		CO2,%	10.00	8.00	10.00	9.50	10.00	9.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
		CO,ppmv	7.00	8.00	7.00	6.00	7.00	6.00	6.00	6.00	6.00	5.00	5.00	5.00	5.00
	Temp.,F		180.00	165.00	183.00	185.00	179.00	179.00	180.00	180.00	179.00	179.00	179.00	179.00	185.00
	Velocity,ft/min		2400.00	1200.00	2100.00	2100.00	2300.00	2400.00	2400.00	2350.00	2400.00	2150.00	2200.00	2000.00	1900.00

AUGUST 1, 1987

			13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Time			13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Feedrate,%			44.00	44.00	0.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
Run Hours			2575.00	2576.00	2577.00	2578.00	2579.00	2580.00	2581.00	2582.00	2583.00	2584.00	2585.00
Primary Chamber	Temp.,F Zones	A1	1699.00	1713.00	1354.00	1631.00	1675.00	1618.00	1630.00	1554.00	1554.00	1541.00	1486.00
		A2	1810.00	1806.00	1507.00	1830.00	1735.00	1722.00	1717.00	1761.00	1814.00	1688.00	1631.00
		A3	1805.00	1825.00	1574.00	1762.00	1786.00	1779.00	1738.00	1771.00	1820.00	1848.00	1768.00
		B1	1776.00	1738.00	1624.00	1790.00	1706.00	1699.00	1722.00	1709.00	1738.00	1755.00	1730.00
		B2	1760.00	1743.00	1663.00	1813.00	1727.00	1670.00	1704.00	1702.00	1733.00	1708.00	1692.00
		B3	1626.00	1276.00	1259.00	1321.00	1202.00	1380.00	1381.00	1346.00	1355.00	1430.00	1396.00
		Exhaust	1819.00	1836.00	1545.00	1788.00	1836.00	1846.00	1858.00	1788.00	1793.00	1818.00	1780.00
		Ash Discharge	209.00	210.00	193.00	188.00	210.00	206.00	209.00	207.00	210.00	211.00	210.00
	Blower Damper,% Open		54.00	54.00	5.00	30.00	46.00	42.00	46.00	46.00	45.00	48.00	50.00
	Draft,in. H2O		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04
	Residence Time,min.		19.00	19.00	19.00	19.00	19.00	19.00	19.00	18.90	13.90	18.00	19.10
Secondary Chamber	Temp.,F	Chamber	1895.00	1901.00	1805.00	1928.00	1923.00	1881.00	1903.00	1916.00	1906.00	1872.00	1899.00
		Exhaust	1855.00	1862.00	1757.00	1877.00	1877.00	1842.00	1863.00	1869.00	1865.00	1841.00	1843.00
	Blower Damper,% Open		12.00	12.00	12.00	20.00	24.00	0.00	0.00	0.00	0.00	0.00	0.00
	Draft,in. H2O												
Scrubber	Delta P,%	Venturi 1											
		Venturi 2	96.00	107.00	107.00	91.00	105.00	102.00	100.00	96.00	99.00	99.00	95.00
	Temp.,F	Quench 1											
		Quench 2	184.00	184.00	168.00	183.00	184.00	184.00	183.00	183.00	183.00	183.00	184.00
	Flow,%	Quench H2O 1											
		Quench H2O 2	62.00	66.00	66.00	69.00	64.00	64.00	64.00	64.00	64.00	64.00	64.00
		Quench Recyc.	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00
		Venturi Recyc.	97.00	99.00	99.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		Chevron Recyc.	59.00	58.00	58.00	57.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00
		Chemical Recyc.	104.00	105.00	105.00	105.00	104.00	104.00	104.00	104.00	104.00	104.00	104.00
	pH		8.20	8.20	8.20	8.30	8.30	8.30	8.00	8.00	8.00	8.00	8.00
	Level		11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50
Stack Exhaust		O2,%	5.20	5.40	9.00	6.50	5.80	5.20	5.50	5.00	5.00	5.50	4.50
		CO2,%	10.00	10.00	7.00	9.50	9.50	9.50	9.00	9.00	8.50	7.50	7.50
		CO,ppmv	5.00	4.00	4.00	5.00	5.00	5.00	7.00	7.00	7.00	7.00	7.00
	Temp.,F		188.00	188.00	171.00	178.00	179.00	179.00	179.00	181.00	180.00	179.00	180.00
	Velocity,ft/min		1900.00	1900.00	700.00	2400.00	2900.00	2600.00	2250.00	2250.00	2350.00	2350.00	2300.00

AUGUST 1, 1987

			AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COFFICIENT OF VARIANCE
Time							
Feedrate,%			40.25	44.00	0.00	12.14	30.17
Run Hours							
Primary	Temp.,F Zones	A1	1623.42	1800.00	1330.00	111.83	6.89
Chamber		A2	1747.79	1841.00	1507.00	82.44	4.72
		A3	1787.38	1858.00	1574.00	64.56	3.61
		B1	1741.75	1793.00	1601.00	47.20	2.71
		B2	1725.38	1813.00	1590.00	40.71	2.36
		B3	1341.38	1626.00	1202.00	87.14	6.50
		Exhaust	1797.33	1936.00	1323.00	121.83	6.78
		Ash Discharge	204.33	211.00	155.00	11.74	5.74
	Blower Damper,% Open		46.10	54.00	5.00	10.33	22.40
	Draft,in. H2O		0.06	0.09	0.04	0.01	19.07
	Residence Time,min.		18.77	20.00	13.90	1.15	6.15
Secondary	Temp.,F	Chamber	1885.79	1940.00	1780.00	35.45	1.88
Chamber		Exhaust	1846.46	1901.00	1757.00	31.28	1.69
	Blower Damper,% Open		9.33	50.00	0.00	11.64	124.74
	Draft,in. H2O						
	Delta P,%	Venturi 1					
Scrubber		Venturi 2	96.54	108.00	72.00	8.92	9.24
	Temp.,F	Quench 1					
		Quench 2			168.00	3.97	
	Flow,%	Quench H2O 1					
		Quench H2O 2	64.00	69.00	62.00	1.44	2.26
		Quench Recyc.	118.00	118.00	118.00	0.00	0.00
		Venturi Recyc.	98.58	100.00	97.00	1.11	1.13
		Chevron Recyc.	59.71	64.00	56.00	3.05	5.10
		Chemical Recyc.	104.50	105.00	104.00	0.50	0.48
	pH		8.04	8.30	7.00	0.24	3.04
	Level		11.55	12.50	11.20	0.23	2.00
Stack		O2,%	5.83	13.50	4.50	1.81	31.04
Exhaust		CO2,%	9.31	10.00	7.00	0.92	9.90
		CO,ppmv	5.92	8.00	4.00	1.08	18.20
	Temp.,F		179.75	188.00	165.00	4.59	2.56
	Velocity,ft/min		2158.33	2900.00	700.00	432.21	20.03

AUGUST 1, 1987

Time					00:00	02:00	04:00	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24:00
Primary Chamber	HEPC	Zone A	Volts	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
				B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
				C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
			Amps	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
				B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
				C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
		Zone B	Volts	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
				B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
				C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
			Amps	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
				B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
				C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
		Draft,in. H2O			0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.10	0.06	0.06	0.07		0.06
		Ash Quench Water, PSI			83.00	79.00	75.00	79.00	79.00	79.00	79.00	79.00	80.00	80.00	80.00		80.00
		Combustion Air,PSI			3.40	2.40	3.40	3.20	3.20	3.20	3.20	3.20	2.80	2.80	3.60		4.00
		Combustion Air,ACFM			1600.00	1400.00	1600.00	1550.00	1550.00	1550.00	1600.00	1600.00	1500.00	1500.00	1500.00		1500.00
Secondary Chamber		Quench Air,PSI			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
		Quench Air,ACFM			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
		Quench Water,PSI			>60.00	>60.00	>60.00	>60.00	>60.00	>60.00	>60.00	>60.00	>60.00	>60.00	>60.00		>60.00
		Quench Water,GPM			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
		Combustion Air,PSI			3.20	4.00	3.00	3.20	3.80	4.80	4.00	3.80	5.00	3.80	4.00		4.00
		Combustion Air,ACFM			3400.00	3500.00	3200.00	3500.00	3250.00	3250.00	3250.00	3000.00	3250.00	3250.00	3100.00		3100.00
		Forced Draft Air,PSI			>20.00	>20.00	>20.00	>20.00	>20.00	>20.00	>20.00	>20.00	>20.00	19.50	20.00		19.50
		Forced Draft Air,ACFM			520.00	400.00	1020.00	420.00	600.00	400.00	400.00	1000.00	1000.00	1100.00	900.00		1100.00
		Propane,PSI			10.00	10.50	8.00	11.00	11.00	11.00	11.00	9.00	8.00	8.00	9.00		8.00
		Propane,SCFH			850.00	550.00	1700.00	550.00	950.00	650.00	650.00	1600.00	1900.00	1900.00	1500.00		1850.00
		Chamber Draft,in. H2O			<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25		<0.25
Air Compressor		Plant Air,PSI			92.00	95.00	97.00	95.00	97.00	96.00	93.00	96.00	97.00	97.00	97.00		95.00
		Plant Air Temp.,F			83.00	83.00	83.00	83.00	82.00	91.00	100.00	98.00	82.00	80.00	93.00		85.00
Quench Tubes		Emergency Quench Water,PSI			78.00	76.00	72.00	76.00	76.00	76.00	79.00	76.00	77.00	76.00	78.00		76.00
		Venturi 1, Delta P in. H2O															
		Venturi 2, Delta P in. H2O			10.00	19.00	22.00	18.00	23.00	23.00	23.00	21.00	23.50	23.00	21.00		22.00

AUGUST 1, 1987

					AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COEFFICIENT OF VARIANCE
Time									
Primary Chamber	HEPC	Zone A	Volts	A	0.00	0.00	0.00		
				B	0.00	0.00	0.00		
				C	0.00	0.00	0.00		
			Amps	A	0.00	0.00	0.00		
				B	0.00	0.00	0.00		
				C	0.00	0.00	0.00		
		Zone B	Volts	A	0.00	0.00	0.00		
				B	0.00	0.00	0.00		
				C	0.00	0.00	0.00		
			Amps	A	0.00	0.00	0.00		
				B	0.00	0.00	0.00		
				C	0.00	0.00	0.00		
		Draft,in. H2C			0.06	0.10	0.06	0.01	17.38
		Ash Quench Water, PSI			79.33	83.00	75.00	1.70	2.14
		Combustion Air,PSI			3.20	4.00	2.40	0.39	12.24
		Combustion Air,ACFM			1537.50	1600.00	1400.00	58.18	3.78
Secondary Chamber		Quench Air,PSI			0.00	0.00	0.00		
		Quench Air,ACFM			0.00	0.00	0.00		
		Quench Water,PSI			>60.00	>60.00	>60.00		
		Quench Water,GPM			0.00	0.00	0.00		
		Combustion Air,PSI			3.88	5.00	3.00	0.57	14.64
		Combustion Air,ACFM			3254.17	3500.00	3000.00	146.43	4.50
		Forced Draft Air,PSI			>20.00	>20.00	19.50		
		Forced Draft Air,ACFM			738.33	1100.00	400.00	290.91	39.40
		Propane,PSI			9.54	11.00	8.00	1.28	13.44
		Propane,SCFH			1220.83	1900.00	550.00	542.55	44.44
		Chamber Draft,in. H2O			<0.25	<0.25	<0.25		
Air Compressor		Plant Air,PSI			95.58	97.00	92.00	1.61	1.68
		Plant Air Temp.,F			86.92	100.00	80.00	6.51	7.49
Quench Tubes		Emergency Quench Water,PSI			76.33	79.00	72.00	1.65	2.16
		Venturi 1, Delta P in. H2O							
		Venturi 2, Delta P in. H2O			20.71	23.50	10.00	3.62	17.48

AUGUST 1, 1987

Time			00:00	02:00	04:00	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24:00
Scrubber	Chevron	Recycle Pump,PSI	48.00	47.00	47.00	47.00	47.00	47.00	48.00	48.00	48.00	48.00	48.00		48.00
	Section	Pump No.	1	1	1	1	1	1	1	1	1	1	1		1
		Sump Temp.F	149.00	148.00	150.00	149.00	150.00	150.00	152.00	152.00	152.00	149.00	146.00		146.00
		Delta P,in. H2O	0.65	0.15	0.00	0.05	0.21	0.23	0.22	0.22	0.23	0.23	0.05		0.00
		Blowdown,GPM													
		Disch. Filter	55.00	55.00	55.00	55.00	54.00	54.00	52.00	52.00	54.00	54.00	54.00		55.00
	Chemical	Recycle,PSI	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00		12.00
	Section	Pump No.	1	1	1	1	1	1	1	1	1	1	1		1
		Sump Temp,F	173.00	170.00	170.00	170.00	170.00	170.00	172.00	172.00	172.00	170.00	172.00		170.00
		Delta P,in. H2O	0.50	1.00	1.40	1.00	1.10	1.30	1.20	1.30	1.50	1.40	1.30		1.40
	Distributor	Level,in.	2.00	0.50	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00		1.00
	Plate	Pressure,PSI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
	Demister	Delta P,in. H2O	0.10	0.10	0.10	0.10	0.10	0.23	0.23	0.23	0.23	0.23	0.10		0.15
	Section														
Chemical		Pump,PSI	15.00	15.00	16.00	16.00	15.00	16.00	16.00	16.00	16.00	15.00	16.00		16.00
Mix Tank		Pump No.	1	1	1	1	1	1	1	1	1	1	1		1
		Temp.,F	124.00	124.00	124.00	124.00	124.00	125.00	125.00	130.00	130.00	129.00	122.00		122.00

AUGUST 1, 1987

Time

			AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COEFFICIENT OF VARIANCE
Scrubber	Chevron	Recycle Pump,PSI	47.58	48.00	47.00	0.49	1.04
	Section	Pump No.					
		Sump Temp.F	149.42	152.00	146.00	1.98	1.32
		Delta P,in. H2O	0.19	0.65	0.00	0.17	89.04
		Blowdown,GPM					
		Disch. Filter	54.08	55.00	52.00	1.04	1.92
	Chemical	Recycle,PSI	12.00	12.00	12.00	0.00	0.00
	Section	Pump No.					
		Sump Temp,F	170.92	173.00	170.00	1.11	0.65
		Delta P,in. H2O	1.20	1.50	0.50	0.26	21.78
	Distributor	Level,in.	0.88	2.00	0.50	0.41	47.38
	Plate	Pressure,PSI	0.00	0.00	0.00		
	Demister	Delta P,in. H2O	0.16	0.23	0.10	0.06	39.17
	Section						
Chemical		Pump,PSI	15.67	16.00	15.00	0.47	3.01
Mix Tank		Pump No.					
		Temp.,F	125.25	130.00	122.00	2.71	2.17

AUGUST 2, 1987

Time			00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00
Feedrate,%			44.00	44.00						40.00	45.00	45.00	45.00	45.00	45.00
Run Hours			2586.00	2587.00						2591.00	2592.00	2593.00	2593.00	2594.00	2595.00
Primary	Temp.,F Zones	A1	1520.00	1535.00						1524.00	1488.00	1593.00	1594.00	1508.00	1617.00
Chamber		A2	1639.00	1666.00						1671.00	1614.00	1663.00	1595.00	1576.00	1683.00
		A3	1749.00	1815.00						1760.00	1764.00	1811.00	1777.00	1731.00	1800.00
		B1	1740.00	1752.00						1591.00	1685.00	1864.00	1689.00	1693.00	1618.00
		B2	1712.00	1727.00						1666.00	1742.00	1669.00	1675.00	1747.00	1705.00
		B3	1398.00	1405.00						1335.00	1448.00	1374.00	1381.00	1376.00	1408.00
		Exhaust	1835.00	1853.00						1800.00	1810.00	1847.00	1909.00	1819.00	1933.00
		Ash Discharge	210.00	210.00						209.00	210.00	210.00	211.00	211.00	211.00
	Blower Damper,% Open		50.00	50.00						10.00	20.00	30.00	40.00	20.00	24.00
	Draft,in. H2O		0.04	0.05						0.03	0.05	0.05	0.05	0.05	0.05
	Residence Time,min.		19.00	17.90						18.70	18.90	19.00	18.60	19.00	18.80
Secondary	Temp.,F	Chamber	1868.00	1879.00						1875.00	1931.00	1905.00	1878.00	1845.00	1867.00
Chamber		Exhaust	1823.00	1841.00						1799.00	1883.00	1850.00	1835.00	1799.00	1829.00
	Blower Damper,% Open		0.00	0.00						0.00	0.00	0.00	0.00	0.00	0.00
	Draft,in, H2O														
	Delta P,%	Venturi 1													
Scrubber		Venturi 2	92.00	93.00						117.00	86.00	93.00	98.00	92.00	113.00
	Temp.,F	Quench 1													
		Quench 2	184.00	184.00						184.00	195.00	201.00	197.00	192.00	195.00
	Flow,%	Quench H2O 1													
		Quench H2O 2	64.00	64.00						66.00	66.00	65.00	65.00	66.00	65.00
		Quench Recyc.	118.00	118.00						118.00	118.00	118.00	118.00	118.00	118.00
		Venturi Recyc.	100.00	100.00						95.00	95.00	96.00	96.00	96.00	96.00
		Chevron Recyc.	55.00	55.00						60.00	61.00	61.00	60.00	60.00	60.00
		Chemical Recyc.	104.00	104.00						90.00	89.00	89.00	89.00	90.00	90.00
	pH		8.00	8.00						9.50	9.50	9.80	9.80	9.00	9.00
	Level		11.50	11.50						11.50	11.60	11.60	11.60	11.60	11.60
Stack		O2,%	5.00	5.50						5.00	5.50	5.00	5.60	6.00	5.50
Exhaust		CO2,%	7.00	6.50						4.00	8.00	7.00	7.00	8.50	8.50
		CO,ppmv	7.00	7.00						3.00	6.00	6.00	6.00	6.00	6.00
	Temp.,F		179.00	180.00						188.00	190.00	189.00	190.00	187.00	188.00
	Velocity,ft/min		2300.00	2300.00						1750.00	1950.00	2050.00	2100.00	2000.00	2100.00

AUGUST 2, 1987

Time			13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Feedrate,%			45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	42.00
Run Hours			2596.00	2597.00	2598.00	2599.00	2600.00	2601.00	2602.00	2603.00	2604.00	2605.00	2606.00
Primary Chamber	Temp.,F Zones	A1	1623.00	1616.00	1660.00	1608.00	1559.00	1573.00	1595.00	1388.00	1268.00	1278.00	1261.00
		A2	1897.00	1651.00	1650.00	1656.00	1611.00	1621.00	1645.00	1636.00	1551.00	1558.00	1544.00
		A3	1803.00	1760.00	1737.00	1719.00	1696.00	1715.00	1774.00	1815.00	1825.00	1793.00	1838.00
		B1	1626.00	1660.00	1667.00	1635.00	1635.00	1648.00	1668.00	1668.00	1727.00	1693.00	1698.00
		B2	1714.00	1663.00	1672.00	1690.00	1671.00	1682.00	1665.00	1692.00	1717.00	1708.00	1713.00
		B3	1403.00	1488.00	1474.00	1542.00	1489.00	1462.00	1566.00	1436.00	1603.00	1494.00	1335.00
		Exhaust	1906.00	1918.00	1905.00	1918.00	1901.00	1846.00	1940.00	1772.00	1653.00	1651.00	1674.00
		Ash Discharge	211.00	211.00	209.00	208.00	208.00	210.00	209.00	209.00	209.00	209.00	204.00
	Blower Damper,% Open		24.00	26.00	23.00	15.00	16.00	17.00	41.00	43.00	39.00	39.00	30.00
	Draft,in. H2O		0.06	0.06	0.05	0.06	0.05	0.05	0.04	0.05	0.05	0.04	0.06
	Residence Time,min.		18.80	18.80	18.70	19.00	19.00	19.00	18.70	19.50	20.30	18.40	18.50
Secondary Chamber	Temp.,F	Chamber	1853.00	1938.00	1904.00	1877.00	1902.00	1876.00	1856.00	1905.00	1913.00	1871.00	1901.00
		Exhaust	1811.00	1878.00	1867.00	1828.00	1840.00	1830.00	1810.00	1848.00	1862.00	1823.00	1851.00
	Blower Damper,% Open		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Draft,in, H2O												
Scrubber	Delta P,%	Venturi 1											
		Venturi 2	106.00	108.00	98.00	94.00	106.00	107.00	105.00	101.00	102.00	99.00	48.00
	Temp.,F	Quench 1											
		Quench 2	188.00	187.00	194.00	189.00	189.00	189.00	198.00	203.00	207.00	206.00	196.00
	Flow,%	Quench H2O 1											
		Quench H2O 2	66.00	66.00	66.00	64.00	64.00	64.00	65.00	65.00	65.00	65.00	65.00
		Quench Recyc.	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00
		Venturi Recyc.	96.00	96.00	96.00	88.00	87.00	86.00	85.00	85.00	85.00	85.00	85.00
		Chevron Recyc.	60.00	60.00	60.00	57.00	56.00	56.00	54.00	54.00	57.00	57.00	57.00
		Chemical Recyc.	90.00	90.00	90.00	88.00	86.00	89.00	87.00	87.00	87.00	87.00	87.00
	pH		9.00	8.60	8.60	8.60	8.50	8.30	8.00	8.00	7.20	5.00	8.00
	Level		11.60	11.60	11.60	12.00	11.50	11.50	11.50	11.50	11.50	11.50	11.50
Stack Exhaust		O2,%	4.50	5.00	5.00	5.00	5.00	4.50	5.50	5.00	5.00	5.00	5.00
		CO2,%	8.70	9.50	9.00	9.50	9.50	9.50	9.50	10.00	10.00	9.50	9.50
		CO,ppmv	6.00	6.00	6.00	6.00	6.00	6.00	6.00	7.00	7.00	7.00	7.00
	Temp.,F		187.00	187.00	187.00	188.00	186.00	186.00	179.00	179.00	180.00	180.00	181.00
	Velocity,ft/min		1910.00	1800.00	1600.00	1200.00	1400.00	1400.00	2000.00	2500.00	2100.00	2200.00	1900.00

AUGUST 2, 1987

			AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COEFFICIENT OF VARIANCE
Time							
Feedrate,%			44.47	45.00	40.00	1.27	2.86
Run Hours							
Primary	Temp.,F Zones	A1	1516.21	1660.00	1261.00	122.48	8.08
Chamber		A2	1638.26	1897.00	1544.00	73.41	4.48
		A3	1772.74	1838.00	1696.00	39.87	2.25
		B1	1681.95	1864.00	1591.00	59.01	3.51
		B2	1696.32	1747.00	1663.00	25.94	1.53
		B3	1443.00	1603.00	1335.00	73.05	5.06
		Exhaust	1836.32	1940.00	1651.00	89.95	4.90
		Ash Discharge	209.42	211.00	204.00	1.60	0.76
	Blower Damper,% Open		29.32	50.00	10.00	11.85	40.44
	Draft,in. H2O		0.05	0.06	0.03	0.01	15.34
	Residence Time,min.		18.87	20.30	17.90	0.46	2.44
Secondary	Temp.,F	Chamber	1886.53	1938.00	1845.00	25.10	1.33
Chamber		Exhaust	1837.21	1883.00	1799.00	23.75	1.29
	Blower Damper,% Open		0.00	0.00	0.00		
	Draft,in, H2O						
	Delta P,%	Venturi 1					
Scrubber		Venturi 2	97.79	117.00	48.00	14.05	14.37
	Temp.,F	Quench 1					
		Quench 2	193.58	207.00	184.00	7.01	3.62
	Flow,%	Quench H2O 1	0.00	0.00	0.00		
		Quench H2O 2	65.05	66.00	64.00	0.76	1.17
		Quench Recyc.	118.00	118.00	118.00	0.00	0.00
		Venturi Recyc.	92.00	100.00	85.00	5.53	6.01
		Chevron Recyc.	57.89	61.00	54.00	2.38	4.11
		Chemical Recyc.	90.16	104.00	86.00	4.92	5.46
	pH		8.44	9.80	5.00	1.06	12.55
	Level		11.57	12.00	11.50	0.11	0.97
Stack		O2,%	5.14	6.00	4.50	0.36	7.07
Exhaust		CO2,%	8.46	10.00	4.00	1.50	17.79
		CO,ppmv	6.16	7.00	3.00	0.87	14.20
	Temp.,F		184.79	190.00	179.00	4.03	2.18
	Velocity,ft/min		1924.21	2500.00	1200.00	327.39	17.01

AUGUST 2, 1987

Time			00:00	02:00	04:00	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24:00
Scrubber	Chevron	Recycle Pump,PSI					50.00	50.00	49.00	48.00	49.00	49.00			
	Section	Pump No.					1	1	1	1	1	1			
		Sump Temp.F					150.00	152.00	153.00	153.00	153.00	153.00			
		Delta P,in. H2O					0.25	0.24	0.25	0.24	0.23	0.22			
		Blowdown,GPM													
		Disch. Filter					52.00	54.00	54.00	52.00	52.00	52.00			
	Chemical	Recycle,PSI					9.00	9.00	9.00	9.00	9.00	9.00			
	Section	Pump No.					1	1	1	1	1	1			
		Sump Temp,F					170.00	170.00	170.00	170.00	170.00	170.00			
		Delta P,in. H2O					1.20	1.20	0.50	0.50	0.50	0.50			
	Distributor	Level,in.					0.00	0.00	0.00	0.00	0.00	0.00			
	Plate	Pressure,PSI					0.00	0.00	0.00	0.00	0.00	0.00			
	Demister	Delta P,in. H2O					0.25	0.26	0.22	0.22	0.23	0.23			
	Section														
Chemical		Pump,PSI					11.00	0.00	16.00	16.00	16.00	10.00			
Mix Tank		Pump No.					1	1	1	1	1	1			
		Temp.,F					119.00	119.00	120.00	121.00	121.00	122.00			

AUGUST 2, 1987

Time

			AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COFFICIENT OF VARIANCE
Scrubber	Chevron	Recycle Pump,PSI	49.17	50.00	48.00	0.69	1.40
	Section	Pump No.					
		Sump Temp.F	152.33	153.00	150.00	1.11	0.73
		Delta P,in. H2O	0.24	0.25	0.22	0.01	4.48
		Blowdown,GPM					
		Disch. Filter	52.67	54.00	52.00	0.94	1.79
	Chemical	Recycle,PSI	9.00	9.00	9.00	0.00	0.00
	Section	Pump No.					
		Sump Temp,F	170.00	170.00	170.00	0.00	0.00
		Delta P,in. H2O	0.73	1.20	0.50	0.33	45.00
	Distributor	Level,in.	0.00	0.00	0.00		
	Plate	Pressure,PSI	0.00	0.00	0.00		
	Demister	Delta P,in. H2O	0.24	0.26	0.22	0.01	6.38
	Section						
Chemical		Pump,PSI	11.50	16.00	0.00	5.71	49.64
Mix Tank		Pump No.					
		Temp.,F	120.33	122.00	119.00	1.11	0.92

AUGUST 2, 1987

Time					00:00	02:00	04:00	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24:00
Primary Chamber	HEPC	Zone A	Volts	A					0.00	0.00	0.00	160.00	160.00	155.00			
				B					0.00	0.00	0.00	150.00	150.00	145.00			
				C					0.00	0.00	0.00	175.00	170.00	175.00			
			Amps	A					0.00	0.00	0.00	600.00	500.00	600.00			
				B					0.00	0.00	0.00	595.00	490.00	580.00			
				C					0.00	0.00	0.00	780.00	740.00	780.00			
		Zone B	Volts	A					0.00	0.00	0.00	0.00	0.00	0.00			
				B					0.00	0.00	0.00	0.00	0.00	0.00			
				C					0.00	0.00	0.00	0.00	0.00	0.00			
			Amps	A					0.00	0.00	0.00	0.00	0.00	0.00			
				B					0.00	0.00	0.00	0.00	0.00	0.00			
				C					0.00	0.00	0.00	0.00	0.00	0.00			
		Draft,in. H2O							0.06	0.05	0.06	0.06	0.07	0.06			
		Ash Quench Water, PSI							84.00	84.00	82.00	80.00	80.00	80.00			
		Combustion Air,PSI							2.20	2.60	1.20	1.20	1.40	1.10			
		Combustion Air,ACFM							1200.00	1500.00	1200.00	1100.00	1100.00	1000.00			
Secondary Chamber		Quench Air,PSI							0.00	0.00	0.00	0.00	0.00	0.00			
		Quench Air,ACFM							0.00	0.00	0.00	0.00	0.00	0.00			
		Quench Water,PSI							>60.00	>60.00	>60.00	>60.00	>60.00	>60.00			
		Quench Water,GPM							0.00	0.00	0.00	0.00	0.00	0.00			
		Combustion Air,PSI							5.80	5.80	8.00	7.90	8.00	>10.00			
		Combustion Air,ACFM							3000.00	3000.00	3500.00	3500.00	3500.00	3500.00			
		Forced Draft Air,PSI							19.50	19.50	20.00	>20.00	>20.00	>20.00			
		Forced Draft Air,ACFM							1250.00	1100.00	1000.00	650.00	740.00	400.00			
		Propane,PSI							8.00	8.00	8.50	11.00	8.00	10.00			
		Propane,SCFH							1800.00	1850.00	1800.00	1050.00	1150.00	650.00			
		Chamber Draft,in. H2O							0.20	<0.25	<0.25	<0.25	<0.25	0.15			
Air Compressor		Plant Air,PSI							92.00	94.00	93.00	90.00	92.00	96.00			
		Plant Air Temp.,F							89.00	92.00	100.00	101.00	101.00	90.00			
Quench Tubes		Emergency Quench Water,PSI							80.00	79.00	69.00	76.00	77.00	77.00			
		Venturi 1, Delta P in. H2O															
		Venturi 2, Delta P in. H2O							20.00	22.00	23.00	23.00	23.00	24.00			

AUGUST 2, 1987

					AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COFFICIENT OF VARIANCE
Time									
Primary Chamber	HEPC	Zone A	Volts	A	79.17	160.00	0.00	79.18	100.02
				B	74.17	150.00	0.00	74.19	100.03
				C	86.67	175.00	0.00	86.68	100.02
			Amps	A	283.33	600.00	0.00	285.29	100.69
				B	277.50	595.00	0.00	279.43	100.70
				C	383.33	780.00	0.00	383.57	100.06
		Zone B	Volts	A	0.00	0.00	0.00		
				B	0.00	0.00	0.00		
				C	0.00	0.00	0.00		
			Amps	A	0.00	0.00	0.00		
				B	0.00	0.00	0.00		
				C	0.00	0.00	0.00		
		Draft,in. H2O			0.06	0.07	0.05	0.01	9.62
		Ash Quench Water, PSI			81.67	84.00	80.00	1.80	2.20
		Combustion Air,PSI			1.62	2.60	1.10	0.57	35.43
		Combustion Air,ACFM			1183.33	1500.00	1000.00	157.23	13.29
Secondary Chamber		Quench Air,PSI			0.00	0.00	0.00		
		Quench Air,ACFM			0.00	0.00	0.00		
		Quench Water,PSI			>60.00	>60.00	>60.00		
		Quench Water,GPM			0.00	0.00	0.00		
		Combustion Air,PSI				>10.00	5.80		
		Combustion Air,ACFM			3333.33	3500.00	3000.00	235.70	7.07
		Forced Draft Air,PSI			>20.00	>20.00	19.50		
		Forced Draft Air,ACFM			856.67	1250.00	400.00	288.48	33.68
		Propane,PSI			8.92	11.00	8.00	1.17	13.12
		Propane,SCFH			1383.33	1850.00	650.00	459.77	33.24
		Chamber Draft,in. H2O			<0.25	0.20	0.15		
Air Compressor		Plant Air,PSI			92.83	96.00	90.00	1.86	2.01
		Plant Air Temp.,F			95.50	101.00	89.00	5.25	5.50
Quench Tubes		Emergency Quench Water,PSI			76.33	80.00	69.00	3.54	4.64
		Venturi 1, Delta P in. H2O							
		Venturi 2, Delta P in. H2O			22.50	24.00	20.00	1.26	5.59

AUGUST 3, 1987

Time			00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00
Feedrate,%			45.00	48.00	48.00	48.00	48.00	48.00	44.00	45.00	45.00	45.00	45.00	45.00	45.00
Run Hours			2607.00	2608.00	2609.00	2610.00	2611.00	2612.00	2613.00	2614.00	2615.00	2616.00	2616.00	2618.00	2619.00
Primary	Temp.,F Zones	A1	1386.00	1388.00	1389.00	1406.00	1640.00	1567.00	1648.00	1614.00	1657.00	1668.00	1631.00	1635.00	1710.00
Chamber		A2	1676.00	1664.00	1735.00	1699.00	1712.00	1702.00	1721.00	1738.00	1657.00	1749.00	1696.00	1700.00	1712.00
		A3	1857.00	1814.00	1727.00	1751.00	1761.00	1808.00	1802.00	1847.00	1714.00	1707.00	1666.00	1688.00	1748.00
		B1	1754.00	1757.00	1805.00	1831.00	1789.00	1821.00	1789.00	1782.00	1708.00	1686.00	1662.00	1636.00	1712.00
		B2	1740.00	1718.00	1744.00	1725.00	1741.00	1733.00	1727.00	1682.00	1623.00	1696.00	1698.00	1691.00	1647.00
		B3	1380.00	1337.00	1533.00	1293.00	1370.00	1344.00	1240.00	1208.00	1268.00	1363.00	1423.00	1507.00	1374.00
		Exhaust	1727.00	1734.00	1743.00	1900.00	1961.00	1928.00	1999.00	1935.00	1976.00	1909.00	1926.00	1952.00	2032.00
		Ash Discharge	210.00	210.00	209.00	209.00	209.00	207.00	207.00	211.00	211.00	211.00	211.00	211.00	211.00
	Blower Damper,% Open		40.00	43.00	50.00	49.00	51.00	51.00	51.00	51.00	48.00	48.00	48.00	50.00	54.00
	Draft,in. H2O		0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.04
	Residence Time,min.		18.60	17.30	18.90	15.60	16.60	17.70	16.60	17.20	17.20	17.00	17.00	18.60	18.00
Secondary	Temp.,F	Chamber	1875.00	1878.00	1943.00	1854.00	1799.00	1882.00	1873.00	1901.00	1907.00	1909.00	1895.00	1915.00	1922.00
Chamber		Exhaust	1843.00	1834.00	1886.00	1818.00	1800.00	1833.00	1829.00	1860.00	1862.00	1865.00	1860.00	1866.00	1876.00
	Blower Damper,% Open		15.00	0.00	55.00	0.00	0.00	15.00	0.00	52.00	48.00	0.00	0.00	0.00	0.00
	Draft,in, H2O														
	Delta P,%	Venturi 1													
Scrubber		Venturi 2	104.00	103.00	90.00	77.00	87.00	89.00	84.00	94.00	104.00	98.00	101.00	101.00	109.00
	Temp.,F	Quench 1													
		Quench 2	203.00	210.00	210.00	212.00	212.00	211.00	207.00	200.00	186.00	190.00	194.00	197.00	201.00
	Flow,%	Quench H2O 1													
		Quench H2O 2	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00
		Quench Recyc.	111.00	112.00	112.00	112.00	112.00	112.00	112.00	112.00	108.00	108.00	106.00	103.00	103.00
		Venturi Recyc.	82.00	82.00	82.00	82.00	82.00	82.00	82.00	82.00	79.00	79.00	78.00	78.00	77.00
		Chevron Recyc.	57.00	57.00	57.00	57.00	57.00	57.00	57.00	57.00	55.00	54.00	53.00	53.00	52.00
		Chemical Recyc.	86.00	86.00	86.00	86.00	86.00	86.00	86.00	86.00	86.00	85.00	85.00	86.00	86.00
	pH		8.00	7.50	7.50	8.00	8.00	8.00	8.00	7.00	7.50	8.50	8.50	8.40	8.40
	Level		11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50	11.50
Stack		O2,%	5.50	5.00	4.50	5.50	5.50	4.50	5.00	5.00	5.00	5.00	5.00	5.20	5.40
Exhaust		CO2,%	9.50	9.50	10.00	9.00	9.50	9.50	9.50	9.50	9.50	9.50	9.50	10.00	10.00
		CO,ppmv	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	8.00
	Temp.,F		180.00	180.00	181.00	185.00	179.00	180.00	180.00	181.00	181.00	186.00	186.00	186.00	181.00
	Velocity,ft/min		2150.00	2100.00	2300.00	2100.00	2200.00	2100.00	2200.00	2300.00	2100.00	1900.00	1400.00	1500.00	1700.00

AUGUST 3, 1987

Time			13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Feedrate,%			45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
Run Hours			2620.00	2621.00	2622.00	2623.00	2624.00	2625.00	2626.00	2627.00	2628.00	2629.00	2630.00
Primary	Temp.,F Zones	A1	1694.00	1674.00	1624.00	1611.00	1599.00	1495.00	1520.00	1536.00	1568.00	1364.00	1400.00
Chamber		A2	1720.00	1719.00	1681.00	1667.00	1654.00	1606.00	1650.00	1649.00	1717.00	1635.00	1634.00
		A3	1765.00	1788.00	1766.00	1743.00	1726.00	1719.00	1753.00	1741.00	1794.00	1733.00	1718.00
		B1	1656.00	1707.00	1706.00	1712.00	1682.00	1646.00	1624.00	1625.00	1666.00	1639.00	1615.00
		B2	1540.00	1610.00	1631.00	1656.00	1596.00	1659.00	1620.00	1565.00	1584.00	1571.00	1563.00
		B3	1250.00	1313.00	1312.00	1349.00	1285.00	1335.00	1344.00	1283.00	1432.00	1359.00	1489.00
		Exhaust	2034.00	1993.00	1939.00	1913.00	1892.00	1870.00	1871.00	1899.00	2014.00	1971.00	2015.00
		Ash Discharge	210.00	210.00	211.00	211.00	210.00	210.00	209.00	209.00	209.00	211.00	209.00
	Blower Damper,% Open		50.00	50.00	48.00	48.00	48.00	21.00	21.00	21.00	34.00	40.00	40.00
	Draft,in. H2O		0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.05	0.04	0.04	0.05
	Residence Time,min.		18.00	17.60	19.00	19.00	19.00	19.00	18.40	18.10	18.50	18.60	18.10
Secondary	Temp.,F	Chamber	1906.00	1872.00	1921.00	1923.00	1854.00	1880.00	1890.00	1867.00	1893.00	1895.00	1873.00
Chamber		Exhaust	1858.00	1844.00	1874.00	1876.00	1816.00	1855.00	1840.00	1823.00	1848.00	1851.00	1830.00
	Blower Damper,% Open		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Draft,in, H2O												
	Delta P,%	Venturi 1											
Scrubber		Venturi 2	100.00	111.00	106.00	66.00	100.00	98.00	102.00	94.00	98.00	93.00	96.00
	Temp.,F	Quench 1											
		Quench 2	212.00	206.00	210.00	200.00	198.00	192.00	194.00	191.00	190.00	194.00	193.00
	Flow,%	Quench H2O 1											
		Quench H2O 2	65.00	66.00	65.00	65.00	65.00	64.00	64.00	64.00	64.00	64.00	64.00
		Quench Recyc.	102.00	101.00	98.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00
		Venturi Recyc.	77.00	76.00	73.00	100.00	99.00	99.00	98.00	98.00	98.00	98.00	98.00
		Chevron Recyc.	51.00	51.00	49.00	60.00	65.00	64.00	63.00	63.00	63.00	63.00	63.00
		Chemical Recyc.	86.00	86.00	86.00	86.00	103.00	102.00	103.00	103.00	103.00	103.00	103.00
	pH		8.20	8.20	8.30	8.50	8.20	8.20	8.00	8.00	8.00	8.00	8.00
	Level		11.50	11.50	11.50	11.50	11.05	13.60	11.50	11.05	12.40	12.00	11.50
Stack		O2,%	5.00	5.20	5.20	5.00	5.20	5.20	5.00	5.50	6.00	5.50	6.00
Exhaust		CO2,%	10.00	10.00	9.50	9.00	9.00	9.00	9.00	9.00	9.00	9.00	8.50
		CO,ppmv	7.00	7.00	7.00	7.00	7.00	6.00	6.00	7.00	7.00	7.00	7.00
	Temp.,F		180.00	180.00	187.00	186.00	185.00	188.00	186.00	185.00	183.00	186.00	186.00
	Velocity,ft/min		1540.00	1700.00	1400.00	1400.00	1900.00	1600.00	1500.00	1400.00	1650.00	1650.00	1700.00

AUGUST 3, 1987

			AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COEFFICIENT OF VARIANCE
Time							
Feedrate,%			45.58	48.00	44.00	1.26	2.75
Run Hours							
Primary Chamber	Temp.,F Zones	A1	1559.33	1710.00	1364.00	110.64	7.10
		A2	1687.21	1749.00	1606.00	36.94	2.19
		A3	1755.67	1857.00	1666.00	46.46	2.65
		B1	1708.75	1831.00	1615.00	66.01	3.86
		B2	1656.67	1744.00	1540.00	64.05	3.87
		B3	1349.63	1533.00	1208.00	80.59	5.97
		Exhaust	1922.21	2034.00	1727.00	85.11	4.43
		Ash Discharge	209.83	211.00	207.00	1.18	0.56
	Blower Damper,% Open		43.96	54.00	21.00	9.78	22.26
	Draft,in. H2O		0.05	0.06	0.04	0.01	12.77
	Residence Time,min.		17.90	19.00	15.60	0.91	5.07
Secondary Chamber	Temp.,F	Chamber	1888.63	1943.00	1799.00	29.14	1.54
		Exhaust	1847.79	1886.00	1800.00	21.41	1.16
	Blower Damper,% Open		7.71	55.00	0.00	17.15	222.46
	Draft,in, H2O						
Scrubber	Delta P,%	Venturi 1					
		Venturi 2	96.04	111.00	66.00	9.98	10.39
	Temp.,F	Quench 1					
		Quench 2	200.54	212.00	186.00	8.30	4.14
	Flow,%	Quench H2O 1					
		Quench H2O 2	64.79	66.00	64.00	0.50	0.77
		Quench Recyc.	111.17	118.00	98.00	6.19	5.57
		Venturi Recyc.	85.88	100.00	73.00	9.22	10.73
		Chevron Recyc.	57.42	65.00	49.00	4.58	7.98
		Chemical Recyc.	90.83	103.00	85.00	7.72	8.50
	pH		8.04	8.50	7.00	0.36	4.43
	Level		11.61	13.60	11.05	0.48	4.16
Stack Exhaust		O2,%	5.20	6.00	4.50	0.36	6.92
		CO2,%	9.40	10.00	8.50	0.41	4.34
		CO,ppmv	6.96	8.00	6.00	0.35	5.05
	Temp.,F		183.25	188.00	179.00	2.89	1.58
	Velocity,ft/min		1812.08	2300.00	1400.00	311.02	17.16

AUGUST 3, 1987

Time					00:00	02:00	04:00	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24:00
Primary Chamber	HEPC	Zone A	Volts	A		0.00	0.00	0.00			0.00	0.00	0.00	70.00	105.00		0.00
				B		0.00	0.00	0.00			0.00	0.00	0.00	90.00	105.00		0.00
				C		0.00	0.00	0.00			0.00	0.00	0.00	150.00	165.00		0.00
			Amps	A		0.00	0.00	0.00			0.00	0.00	0.00	350.00	410.00		0.00
				B		0.00	0.00	0.00			0.00	0.00	0.00	375.00	420.00		0.00
				C		0.00	0.00	0.00			0.00	0.00	0.00	615.00	700.00		0.00
		Zone B	Volts	A		0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00		0.00
				B		0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00		0.00
				C		0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00		0.00
			Amps	A		0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00		0.00
				B		0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00		0.00
				C		0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00		0.00
		Draft,in. H2O				0.06	0.06	0.06	0.06		0.06	0.05	0.05	0.05	0.06		0.05
		Ash Quench Water, PSI				82.00	72.00	82.00	82.00		82.00	82.00	82.00	81.00	81.00		81.00
		Combustion Air,PSI				3.60	3.40	3.40	2.40		3.00	2.80	2.80	1.10	1.10		1.00
		Combustion Air,ACFM				1550.00	1600.00	1700.00	1500.00		1750.00	1600.00	1500.00	1000.00	1000.00		1000.00
Secondary Chamber		Quench Air,PSI				0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00
		Quench Air,ACFM				0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00
		Quench Water,PSI				>60.00	>60.00	>60.00	>60.00		>60.00	>60.00	>60.00	>60.00	>60.00		>60.00
		Quench Water,GPM				0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00
		Combustion Air,PSI				>10	8.20	8.00	8.80		8.00	8.00	8.00	8.30	8.20		8.00
		Combustion Air,ACFM				3800.00	3600.00	3600.00	3800.00		3600.00	3800.00	3800.00	3800.00	2800.00		3600.00
		Forced Draft Air,PSI				>20	19.50	20.00	19.50		20.00	19.50	19.50	19.50	19.50		19.50
		Forced Draft Air,ACFM				660.00	1040.00	1000.00	1050.00		1050.00	1000.00	1000.00	1100.00	1400.00		1400.00
		Propane,PSI				10.50	8.00	9.00	8.00		4.50	4.80	4.80	4.80	8.00		8.00
		Propane,SCFH				1000.00	1800.00	1550.00	1850.00		1900.00	1750.00	1850.00	1850.00	1830.00		1850.00
		Chamber Draft,in. H2O				<0.25	<0.25	<0.25	<0.25		<0.25	<0.25	<0.25	0.23	<0.25		<0.25
Air Compressor		Plant Air,PSI				92.00	92.00	92.00	92.00		92.00	92.00	90.00	90.00	92.00		95.00
		Plant Air Temp.,F				85.00	85.00	83.00	85.00		89.00	90.00	96.00	94.00	97.00		95.00
Quench Tubes		Emergency Quench Water,PSI				98.00	69.00	78.00	78.00		77.00	78.00	79.00	77.00	76.00		78.00
		Venturi 1, Delta P in. H2O															
		Venturi 2, Delta P in. H2O				18.00	18.00	19.00	22.00		24.00	25.00	21.00	20.00	21.50		

AUGUST 3, 1987

				AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COEFFICIENT OF VARIANCE
Time								
Primary Chamber	HEPC	Zone A Volts	A	19.44	105.00	0.00	37.30	191.83
			B	21.67	105.00	0.00	40.69	187.79
			C	35.00	165.00	0.00	65.57	187.36
		Amps	A	84.44	410.00	0.00	158.61	187.83
			B	88.33	420.00	0.00	165.60	187.47
			C	146.11	700.00	0.00	274.08	187.58
		Zone B Volts	A	0.00	0.00	0.00		
			B	0.00	0.00	0.00		
			C	0.00	0.00	0.00		
		Amps	A	0.00	0.00	0.00		
			B	0.00	0.00	0.00		
			C	0.00	0.00	0.00		
		Draft, in. H2O		0.06	0.06	0.05	0.00	8.75
		Ash Quench Water, PSI		80.70	82.00	72.00	2.93	3.64
		Combustion Air, PSI		2.46	3.60	1.00	0.97	39.46
		Combustion Air, ACFM		1420.00	1750.00	1000.00	284.78	20.05
Secondary Chamber		Quench Air, PSI		0.00	0.00	0.00		
		Quench Air, ACFM		0.00	0.00	0.00		
		Quench Water, PSI		>60.00	>60.00	>60.00		
		Quench Water, GPM		0.00	0.00	0.00		
		Combustion Air, PSI		7.35	8.80	0.00	2.46	33.49
		Combustion Air, ACFM		3620.00	3800.00	2800.00	289.14	7.99
		Forced Draft Air, PSI		17.65	20.00	0.00	5.89	33.35
		Forced Draft Air, ACFM		1070.00	1400.00	660.00	200.80	18.77
		Propane, PSI		7.04	10.50	4.50	2.02	28.76
		Propane, SCFH		1723.00	1900.00	1000.00	258.19	14.98
		Chamber Draft, in. H2O		<0.25	<0.25	0.23		
Air Compressor		Plant Air, PSI		91.90	95.00	90.00	1.30	1.41
		Plant Air Temp., F		89.90	97.00	83.00	5.01	5.57
Quench Tubes		Emergency Quench Water, PSI		78.80	98.00	69.00	6.94	8.81
		Venturi 1, Delta P in. H2O						
		Venturi 2, Delta P in. H2O		20.94	25.00	18.00	2.34	11.17

AUGUST 3, 1987

Time			02:00	04:00	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24:00
Scrubber	Chevron Section	Recycle Pump,PSI	48.00	48.00	48.00	48.00		50.00	50.00	48.00	48.00	48.00		48.00
		Pump No.	1	1	1	1		1	1	1	1	1		1
		Sump Temp.F	151.00	151.00	152.00	152.00		151.00	151.00	152.00	151.00	152.00		150.00
		Delta P,in. H2O	0.10	0.00	0.10	0.00		0.00	0.10	0.05	0.25	0.00		0.25
		Blowdown,GPM						10.00	10.00	10.00	10.00	10.00		10.00
		Disch. Filter	56.00	56.00	56.00	55.00						55.00		55.00
	Chemical Section	Recycle,PSI	8.00	8.00	8.00	8.00		8.00	9.00	9.00	11.00	11.00		11.00
		Pump No.	1	1	1	1		1	1	1	1	1		1
		Sump Temp,F	170.00	170.00	172.00	172.00		172.00	172.00	172.00	170.00	172.00		170.00
		Delta P,in. H2O	0.30	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00
	Distributor	Level,in.	0.00	0.00	0.00	0.00		0.00	0.00	0.00	.25-.50	.25-.50		
	Plate	Pressure,PSI	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00
	Demister Section	Delta P,in. H2O	0.30	0.25	0.25	0.25		0.27	0.26	0.25	0.24	0.20		0.25
Chemical Mix Tank		Pump,PSI	16.00	16.00	16.00	16.00		16.00	15.00	18.00	18	18.00		18.00
		Pump No.	1	1	1	1		1	1	1	1	1		1
		Temp.,F	122.00	122.00	122.00	122.00						120.00		120.00

AUGUST 3, 1987

			AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COEFFICIENT OF VARIANCE
Time							
Scrubber	Chevron Section	Recycle Pump,PSI	48.40	50.00	48.00	0.80	1.65
		Pump No.					
		Sump Temp.F	151.30	152.00	150.00	0.64	0.42
		Delta P,in. H2O	0.09	0.25	0.00	0.09	108.62
		Blowdown,GPM	8.57	10.00	0.00	3.50	40.82
		Disch. Filter	33.30	56.00	0.00	27.19	81.66
	Chemical Section	Recycle,PSI	9.10	11.00	8.00	1.30	14.29
		Pump No.					
		Sump Temp,F	171.20	172.00	170.00	0.98	0.57
		Delta P,in. H2O	0.03	0.30	0.00	0.09	300.00
	Distributor Plate	Level,in.					
		Pressure,PSI	0.00	0.00	0.00		
	Demister Section	Delta P,in. H2O	0.25	0.30	0.20	0.02	9.36
Chemical Mix Tank		Pump,PSI	16.70	18.00	15.00	1.10	6.59
		Pump No.					
		Temp.,F	72.80	122.00	0.00	59.45	81.66

AUGUST 4, 1987

Time			00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00
Feedrate,%			45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
Run Hours			2631.00	2632.00	2633.00	2634.00	2635.00	2636.00	2637.00	2638.00	2639.00	2640.00	2641.00	2642.00	2643.00
Primary Chamber	Temp.,F Zones	A1	1516.00	1451.00	1457.00	1434.00	1411.00	1432.00	1388.00	1462.00	1461.00	1445.00	1382.00	1417.00	1407.00
		A2	1689.00	1648.00	1664.00	1666.00	1658.00	1677.00	1625.00	1620.00	1650.00	1634.00	1585.00	1598.00	1610.00
		A3	1740.00	1789.00	1788.00	1713.00	1755.00	1809.00	1780.00	1768.00	1736.00	1736.00	1680.00	1679.00	1669.00
		B1	1509.00	1594.00	1605.00	1615.00	1631.00	1696.00	1647.00	1671.00	1664.00	1663.00	1642.00	1632.00	1635.00
		B2	1462.00	1619.00	1573.00	1558.00	1577.00	1653.00	1572.00	1605.00	1637.00	1595.00	1579.00	1605.00	1553.00
		B3	1464.00	1615.00	1650.00	1438.00	1543.00	1685.00	1651.00	1558.00	1536.00	1147.00	1093.00	1119.00	1100.00
		Exhaust	2083.00	1937.00	2011.00	1980.00	1939.00	2005.00	2047.00	1926.00	1958.00	1888.00	1879.00	1920.00	1918.00
		Ash Discharge	209.00	210.00	210.00	206.00	210.00	210.00	209.00	207.00	209.00	205.00	205.00	202.00	203.00
	Blower Damper,% Open		45.00	40.00	40.00	40.00	42.00	45.00	45.00	45.00	40.00	31.00	24.00	22.00	23.00
	Draft,in. H2O		0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.06	0.06	0.06	0.06	0.05	0.05
	Residence Time,min.		17.90	18.60	18.60	18.80	19.30	18.80	19.00	18.40	19.00	19.00	19.00	19.00	19.00
Secondary Chamber	Temp.,F	Chamber	1912.00	1935.00	1932.00	1866.00	1922.00	1920.00	1923.00	1913.00	1923.00	1892.00	1884.00	1913.00	1849.00
		Exhaust	1850.00	1873.00	1874.00	1837.00	1870.00	1867.00	1873.00	1873.00	1898.00	1851.00	1834.00	1860.00	1818.00
	Blower Damper,% Open		0.00	45.00	20.00	0.00	0.00	30.00	20.00	30.00	0.00	0.00	0.00	0.00	0.00
	Draft,in. H2O														
Scrubber	Delta P,%	Venturi 1													
		Venturi 2	94.00	102.00	85.00	75.00	79.00	86.00	85.00	72.00	104.00	100.00	112.00	92.00	92.00
	Temp.,F	Quench 1													
		Quench 2	194.00	189.00	190.00	189.00	189.00	194.00	192.00	191.00	191.00	190.00	189.00	190.00	190.00
	Flow,%	Quench H2O 1													
		Quench H2O 2	65.00	65.00	65.00	65.00	65.00	65.00	64.00	64.00	63.00	65.00	65.00	65.00	65.00
		Quench Recyc.	118.00	118.00	118.00	118.00	118.00	118.00	117.00	116.00	118.00	118.00	118.00	118.00	118.00
		Venturi Recyc.	98.00	98.00	98.00	98.00	98.00	98.00	97.00	96.00	99.00	98.00	99.00	97.00	100.00
		Chevron Recyc.	60.00	60.00	60.00	60.00	60.00	60.00	55.00	53.00	54.00	53.00	53.00	53.00	53.00
		Chemical Recyc.	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00	97.00	96.00	97.00
	pH		8.00	7.50	8.00	8.00	8.00	7.70	7.70	7.70	8.00	8.00	8.00	8.00	8.00
	Level		12.00	15.00	11.00	10.00	12.00	10.50	12.40	10.60	11.00	11.50	11.50	11.50	11.50
Stack Exhaust		O2,%	5.00	5.50	5.00	6.50	5.00	5.00	5.00	5.00	5.20	5.50	5.50	5.20	5.00
		CO2,%	9.00	5.00	9.00	8.50	9.00	9.00	8.50	8.00	7.00	9.00	9.00	9.50	9.00
		CO,ppmv	7.00	7.00	7.00	6.00	7.00	6.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
	Temp.,F		186.00	185.00	185.00	182.00	183.00	180.00	180.00	186.00	184.00	186.00	186.00	186.00	186.00
	Velocity,ft/min		1700.00	1800.00	1800.00	1600.00	1850.00	1850.00	1850.00	1700.00	2000.00	1650.00	1650.00	1450.00	1500.00

AUGUST 4, 1987

Time			13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Feedrate,%			45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
Run Hours			2644.00	2645.00	2646.00	2647.00	2648.00	2649.00	2650.00	2651.00	2652.00	2653.00	2654.00
Primary	Temp.,F Zones	A1	1439.00	1447.00	1481.00	1513.00	1542.00	1508.00	1541.00	1555.00	1546.00	1519.00	1524.00
Chamber		A2	1581.00	1616.00	1604.00	1627.00	1711.00	1689.00	1710.00	1689.00	1699.00	1675.00	1664.00
		A3	1659.00	1669.00	1647.00	1686.00	1783.00	1716.00	1708.00	1783.00	1800.00	1731.00	1704.00
		B1	1588.00	1591.00	1572.00	1589.00	1618.00	1599.00	1753.00	1654.00	1648.00	1591.00	1574.00
		B2	1612.00	1629.00	1587.00	1622.00	1566.00	1616.00	1599.00	1619.00	1617.00	1597.00	1583.00
		B3	1321.00	1264.00	1472.00	1586.00	1334.00	1246.00	1078.00	1199.00	1230.00	1197.00	1119.00
		Exhaust	1264.00	1866.00	1867.00	1892.00	1916.00	1930.00	1897.00	1740.00	1738.00	1794.00	1837.00
		Ash Discharge	206.00	205.00	209.00	209.00	204.00	210.00	207.00	202.00	204.00	208.00	207.00
	Blower Damper,% Open		16.00	16.00	17.00	27.00	22.00	22.00	12.00	12.00	12.00	12.00	12.00
	Draft,in. H2O		0.04	0.05	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.04
	Residence Time,min.		19.00	19.00	19.00	19.00	19.00	19.00	19.20	19.00	19.10	18.90	18.50
Secondary	Temp.,F	Chamber	1924.00	1903.00	1923.00	1901.00	1920.00	1843.00	1893.00	1942.00	1929.00	1912.00	1889.00
Chamber		Exhaust	1864.00	1861.00	1851.00	1857.00	1883.00	1805.00	1840.00	1888.00	1872.00	1861.00	1842.00
	Blower Damper,% Open		0.00	0.00	0.00	15.00	0.00	0.00	0.00	40.00	30.00	0.00	0.00
	Draft,in. H2O												
	Delta P,%	Venturi 1											
Scrubber		Venturi 2	116.00	111.00	117.00	109.00	110.00	110.00	100.00	103.00	99.00	99.00	99.00
	Temp.,F	Quench 1											
		Quench 2	188.00	189.00	186.00	188.00	184.00	184.00	185.00	186.00	186.00	186.00	185.00
	Flow,%	Quench H2O 1											
		Quench H2O 2	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00
		Quench Recyc.	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00	118.00
		Venturi Recyc.	99.00	99.00	99.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		Chevron Recyc.	53.00	53.00	53.00	53.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00
		Chemical Recyc.	97.00	97.00	97.00	97.00	97.00	97.00	97.00	97.00	97.00	97.00	97.00
	pH		8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	Level		11.50	11.50	11.50	11.50	11.50	11.60	11.50	11.50	11.50	11.50	11.50
Stack		O2,%	5.30	5.30	5.00	5.00	5.00	6.00	5.50	5.00	5.50	5.00	5.50
Exhaust		CO2,%	9.50	9.30	10.00	9.00	9.50	8.50	9.00	9.50	9.50	9.00	9.00
		CO,ppmv	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	6.00	7.00
	Temp.,F		185.00	187.00	185.00	187.00	185.00	184.00	185.00	185.00	185.00	187.00	186.00
	Velocity,ft/min		1500.00	1450.00	1600.00	2000.00	1750.00	1650.00	1550.00	1500.00	1700.00	1500.00	1500.00

AUGUST 4, 1987

			AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COEFFICIENT OF VARIANCE
Time							
Feedrate,%			45.00	45.00	45.00	0.00	0.00
Run Hours							
Primary	Temp.,F Zones	A1	1469.92	1555.00	1382.00	51.77	3.52
Chamber		A2	1649.54	1711.00	1581.00	38.31	2.32
		A3	1730.33	1809.00	1647.00	48.48	2.80
		B1	1624.21	1753.00	1509.00	47.81	2.94
		B2	1593.13	1653.00	1462.00	37.07	2.33
		B3	1360.21	1685.00	1078.00	203.85	14.99
		Exhaust	1884.67	2083.00	1264.00	153.09	8.12
		Ash Discharge	206.92	210.00	202.00	2.61	1.26
	Blower Damper,% Open		27.58	45.00	12.00	12.54	45.45
	Draft,in. H2O		0.05	0.06	0.04	0.01	13.63
	Residence Time,min.		18.88	19.30	17.90	0.29	1.54
Secondary	Temp.,F	Chamber	1906.79	1942.00	1843.00	25.27	1.33
Chamber		Exhaust	1858.42	1898.00	1805.00	21.11	1.14
	Blower Damper,% Open		9.58	45.00	0.00	14.64	152.79
	Draft,in. H2O						
	Delta P,%	Venturi 1					
Scrubber		Venturi 2	97.96	117.00	72.00	12.39	12.65
	Temp.,F	Quench 1					
		Quench 2	188.54	194.00	184.00	2.78	1.48
	Flow,%	Quench H2O 1					
		Quench H2O 2	64.83	65.00	63.00	0.47	0.73
		Quench Recyc.	117.88	118.00	116.00	0.44	0.37
		Venturi Recyc.	98.79	100.00	96.00	1.15	1.17
		Chevron Recyc.	54.58	60.00	52.00	3.20	5.86
		Chemical Recyc.	99.04	102.00	96.00	2.51	2.53
	pH		7.94	8.00	7.50	0.14	1.70
	Level		11.55	15.00	10.00	0.87	7.52
Stack		O2,%	5.27	6.50	5.00	0.37	6.98
Exhaust		CO2,%	8.80	10.00	5.00	0.98	11.16
		CO,ppmv	6.88	7.00	6.00	0.33	4.81
	Temp.,F		184.83	187.00	180.00	1.86	1.01
	Velocity,ft/min		1670.83	2000.00	1450.00	161.32	9.66

AUGUST 4, 1987

Time					00:00	02:00	04:00	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24:00
Primary Chamber	HEPC	Zone A	Volts	A	170.00	170.00	170.00	0.00	75.00	0.00	60.00	115.00	80.00	110.00	0.00		140.00
				B	170.00	150.00	170.00	0.00	85.00	0.00	70.00	115.00	95.00	115.00	0.00		130.00
				C	175.00	175.00	175.00	0.00	145.00	0.00	85.00	160.00	130.00	125.00	0.00		175.00
			Amps	A	640.00	640.00	660.00	0.00	320.00	0.00	300.00	480.00	320.00	360.00	0.00		560.00
				B	645.00	600.00	660.00	0.00	360.00	0.00	320.00	660.00	400.00	380.00	0.00		520.00
				C	740.00	760.00	670.00	0.00	680.00	0.00	460.00	720.00	480.00	440.00	0.00		740.00
		Zone B	Volts	A	0.00	0.00	0.00	0.00	680.00	0.00	460.00	720.00	480.00	440.00	0.00		0.00
				B	0.00	0.00	0.00	0.00	680.00	0.00	460.00	720.00	480.00	440.00	0.00		0.00
				C	0.00	0.00	0.00	0.00	680.00	0.00	460.00	720.00	480.00	440.00	0.00		0.00
			Amps	A	0.00	0.00	0.00	0.00	680.00	0.00	460.00	720.00	480.00	440.00	0.00		0.00
				B	0.00	0.00	0.00	0.00	680.00	0.00	460.00	720.00	480.00	440.00	0.00		0.00
				C	0.00	0.00	0.00	0.00	680.00	0.00	460.00	720.00	480.00	440.00	0.00		0.00
		Draft,in. H2O			0.05	0.06	0.07	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.04
		Ash Quench Water, PSI			75.00	75.00	68.00	80.00	78.00	78.00	78.00	78.00	78.00	78.00	85.00		83.00
		Combustion Air,PSI			4.80	4.60	4.40	4.00	1.00	2.40	0.80	1.20	1.40	0.80	0.60		0.60
		Combustion Air,ACFM			1250.00	1250.00	1250.00	1900.00	1250.00	1300.00	1000.00	1250.00	1300.00	1100.00	1000.00		1000.00
Secondary Chamber		Quench Air,PSI			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
		Quench Air,ACFM			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
		Quench Water,PSI			>60.00	>60.00	>60.00	>60.00	>60.00	>60.00	>60.00	>60.00	>60.00	>60.00	>60.00		>60.00
		Quench Water,GPM			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
		Combustion Air,PSI			9.20	8.40	8.40	>10.00	8.00	8.20	6.80	8.40	8.00	8.00	9.80		8.00
		Combustion Air,ACFM			3000.00	3100.00	3200.00	3200.00	3200.00	3300.00	3400.00	2300.00	2600.00	2300.00	3300.00		<2300
		Forced Draft Air,PSI			19.50	19.50	>20.00	>20.00	>20.00	>20.00	>20.00	>20.00	>20.00	>20.00	>20.00		19.50
		Forced Draft Air,ACFM			1300.00	1050.00	500.00	750.00	1000.00	900.00	1000.00	840.00	900.00	1000.00	760.00		1020.00
		Propane,PSI			8.00	8.00	11.00	10.00	8.00	8.00	8.00	9.00	9.00	8.00	10.00		8.50
		Propane,SCFH			1450.00	1850.00	650.00	1200.00	1850.00	1750.00	1850.00	1450.00	1550.00	1850.00	1250.00		1700.00
		Chamber Draft,in. H2O			<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.25	<0.25	<0.25	<0.25	<0.25		0.23
Air Compressor		Plant Air,PSI			95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	98.00		90.00
		Plant Air Temp.,F			93.00	95.00	93.00	87.00	87.00	87.00	90.00	92.00	92.00	92.00	88.00		88.00
Quench Tubes		Emergency Quench Water,PSI			72.00	75.00	75.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	80.00		80.00
		Venturi 1, Delta P in. H2O															
		Venturi 2, Delta P in. H2O			14.00	17.00	16.00	18.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00		22.00

AUGUST 4, 1987

Time

					AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COEFFICIENT OF VARIANCE
Primary Chamber	HEPC	Zone A	Volts	A	90.83	170.00	0.00	63.40	69.80
				B	91.67	170.00	0.00	60.53	66.03
				C	112.08	175.00	0.00	69.60	62.09
			Amps	A	356.67	660.00	0.00	240.95	67.56
				B	378.75	660.00	0.00	247.08	65.24
				C	474.17	760.00	0.00	294.41	62.09
		Zone B	Volts	A	231.67	720.00	0.00	284.66	122.87
				B	231.67	720.00	0.00	284.66	122.87
				C	231.67	720.00	0.00	284.66	122.87
			Amps	A	231.67	720.00	0.00	284.66	122.87
				B	231.67	720.00	0.00	284.66	122.87
				C	231.67	720.00	0.00	284.66	122.87
		Draft,in. H2O			0.05	0.07	0.04	0.01	13.30
		Ash Quench Water, PSI			77.83	85.00	68.00	4.04	5.19
		Combustion Air,PSI			2.22	4.80	0.60	1.65	74.53
		Combustion Air,ACFM			1237.50	1900.00	1000.00	230.15	18.60
Secondary Chamber		Quench Air,PSI			0.00	0.00	0.00		
		Quench Air,ACFM			0.00	0.00	0.00		
		Quench Water,PSI			>60.00	>60.00	>60.00		
		Quench Water,GPM			0.00	0.00	0.00		
		Combustion Air,PSI				>10.00	6.80		
		Combustion Air,ACFM			2990.91	3400.00	<2300		
		Forced Draft Air,PSI			>20.00	>20.00	19.50		
		Forced Draft Air,ACFM			918.33	1300.00	500.00	188.98	20.58
		Propane,PSI			8.79	11.00	8.00	0.99	11.25
		Propane,SCFH			1533.33	1850.00	650.00	349.01	22.76
		Chamber Draft,in. H2O			<0.25	0.25	<0.25		
Air Compressor		Plant Air,PSI			94.83	98.00	90.00	1.67	1.77
		Plant Air Temp.,F			90.33	95.00	87.00	2.72	3.01
Quench Tubes		Emergency Quench Water,PSI			76.17	80.00	72.00	2.03	2.67
		Venturi 1, Delta P in. H2O							
		Venturi 2, Delta P in. H2O			20.08	22.00	14.00	2.84	14.15

AUGUST 4, 1987

Time			00:00	02:00	04:00	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24:00
Scrubber	Chevron	Recycle Pump,PSI	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00		48.00
	Section	Pump No.	1	1	1	1	1	1	1	1	1	1	1		1
		Sump Temp.F	152.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	152.00	152.00	152.00		152.00
		Delta P,in. H2O	0.30	0.05	0.20	0.10	0.25	0.25	0.25	0.00	0.25	0.25	0.20		0.05
		Blowdown,GPM	80.00	70.00	50.00	30.00	20.00	25.00	25.00	30.00	30.00	30.00	15.00		20.00
		Disch. Filter	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00	57.00	57.00	57.00		57.00
	Chemical	Recycle,PSI	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00		11.00
	Section	Pump No.	1	1	1	1	1	1	1	1	1	1	1		1
		Sump Temp,F	172.00	172.00	172.00	172.00	172.00	172.00	172.00	172.00	174.00	174.00	170.00		170.00
		Delta P,in. H2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
	Distributor	Level,in.	.25-.50	.25-.50	.25-.50	.25-.50	0.25	0.25	.25-.50	.50-1.0	.50-1.0	.50-1.0	.50-1.0		0.50
	Plate	Pressure,PSI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
	Demister	Delta P,in. H2O	0.30	0.25	0.20	0.25	0.25	0.30	0.25	0.20	0.25	0.30	0.20		0.20
	Section														
Chemical		Pump,PSI	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00		18.00
Mix Tank		Pump No.	1	1	1	1	1	1	1	1	1	1	1		1
		Temp.,F	122.00	122.00	122.00	122.00	122.00	122.00	122.00	120.00	120.00	122.00	118.00		118.00

AUGUST 4, 1987

Time

			AVERAGE	MAXIMUM	MINIMUM	STANDARD DEVIATION	COEFFICIENT OF VARIANCE
Scrubber	Chevron Section	Recycle Pump,PSI	48.00	48.00	48.00		
		Pump No.					
		Sump Temp.F	150.83	152.00	150.00	0.99	0.65
		Delta P,in. H2O	0.18	0.30	0.00	0.10	53.99
		Blowdown,GPM	35.42	80.00	15.00	19.63	55.42
		Disch. Filter	55.67	57.00	55.00	0.94	1.69
	Chemical Section	Recycle,PSI	11.00	11.00	11.00	0.00	0.00
		Pump No.					
		Sump Temp,F	172.00	174.00	170.00	1.15	0.67
		Delta P,in. H2O	0.00	0.00	0.00		
	Distributor Plate	Level,in.	0.08	0.50	0.00	0.16	187.08
		Pressure,PSI	0.00	0.00	0.00		
	Demister Section	Delta P,in. H2O	0.25	0.30	0.20	0.04	15.44
Chemical Mix Tank		Pump,PSI	18.00	18.00	18.00	0.00	0.00
		Pump No.					
		Temp.,F	121.00	122.00	118.00	1.53	1.26

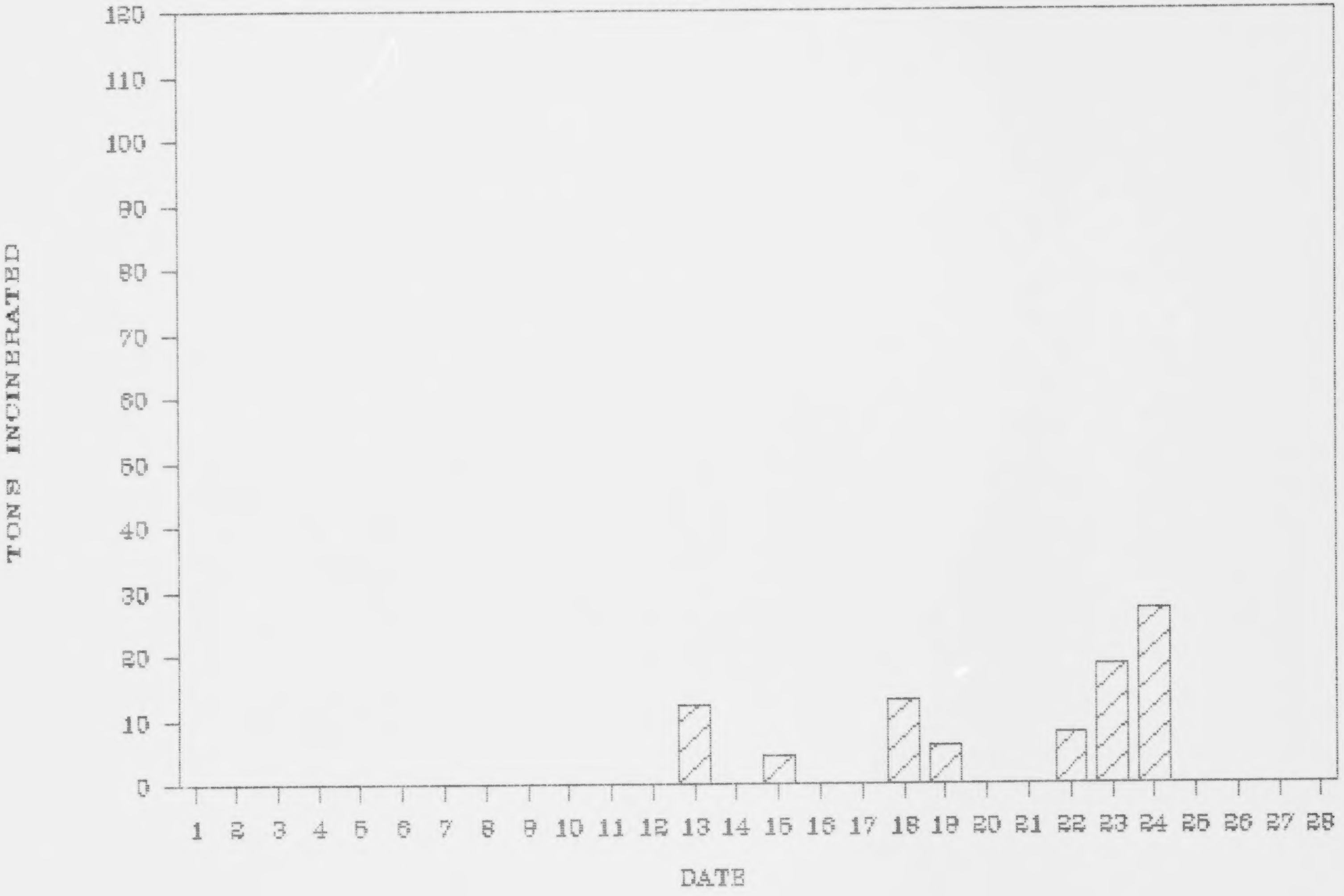
SUMMARY
FEED TABULATION FORMS
WASTE FEED RATE
OPERATOR INPUT

DATE	TIME	TOTAL TONS
8/1/87	0000-0800	28.773
	0800-1600	30.216
	1600-2400	31.280
	TOTAL	90.269
8/2/87	0000-0800	12.574
	0800-1600	32.987
	1600-2400	27.854
	TOTAL	73.415
8/3/87	0000-0800	35.700
	0800-1600	33.855
	1600-2400	29.920
	TOTAL	99.475
8/4/87	0000-0800	32.720
	0800-1600	30.433
	1600-2400	35.799
	TOTAL	98.952

COMPUTER GRAPHS
DAILY WASTE FEEDRATES

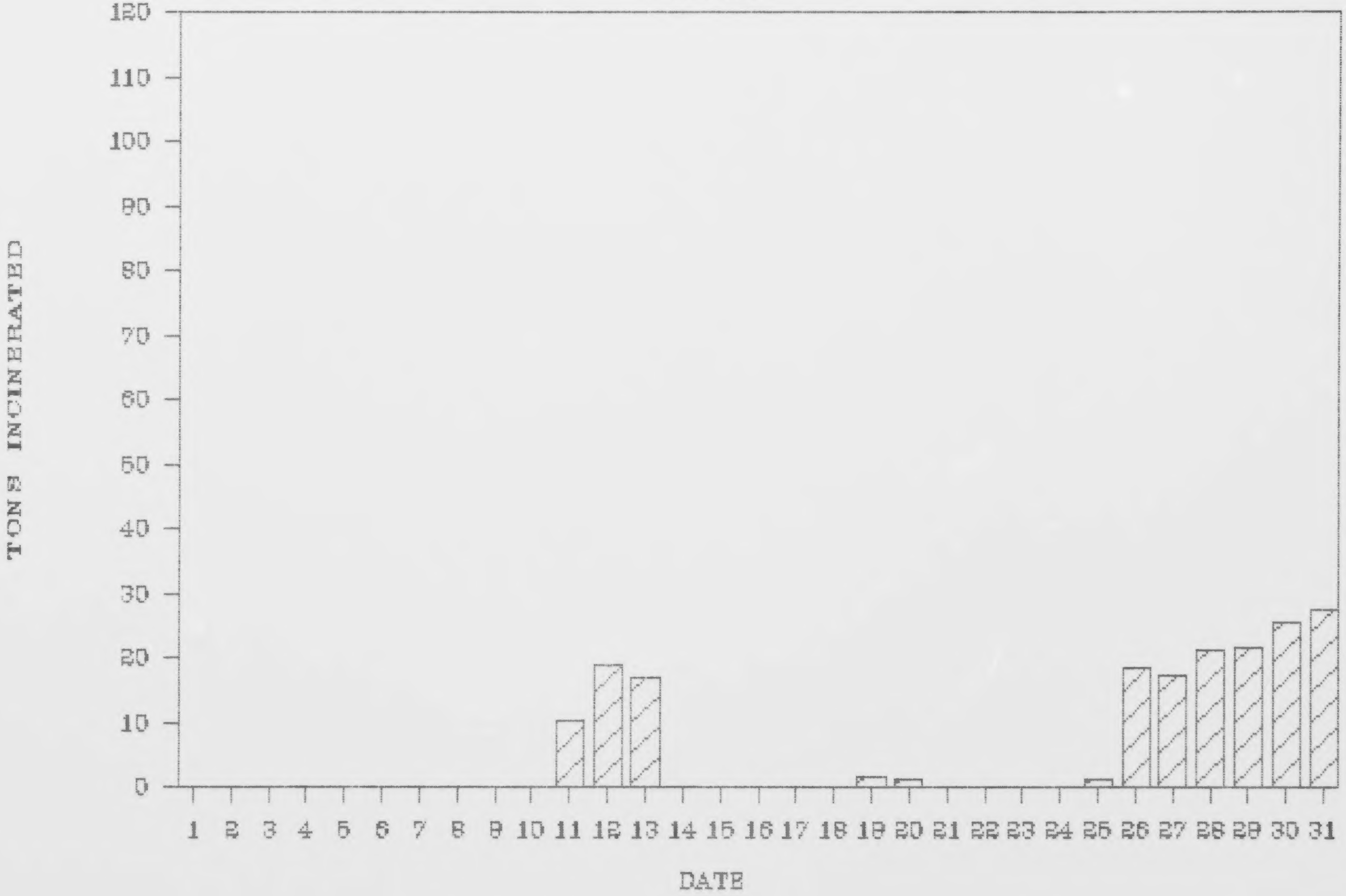
PEAK OIL–INCINERATION

FEBRUARY



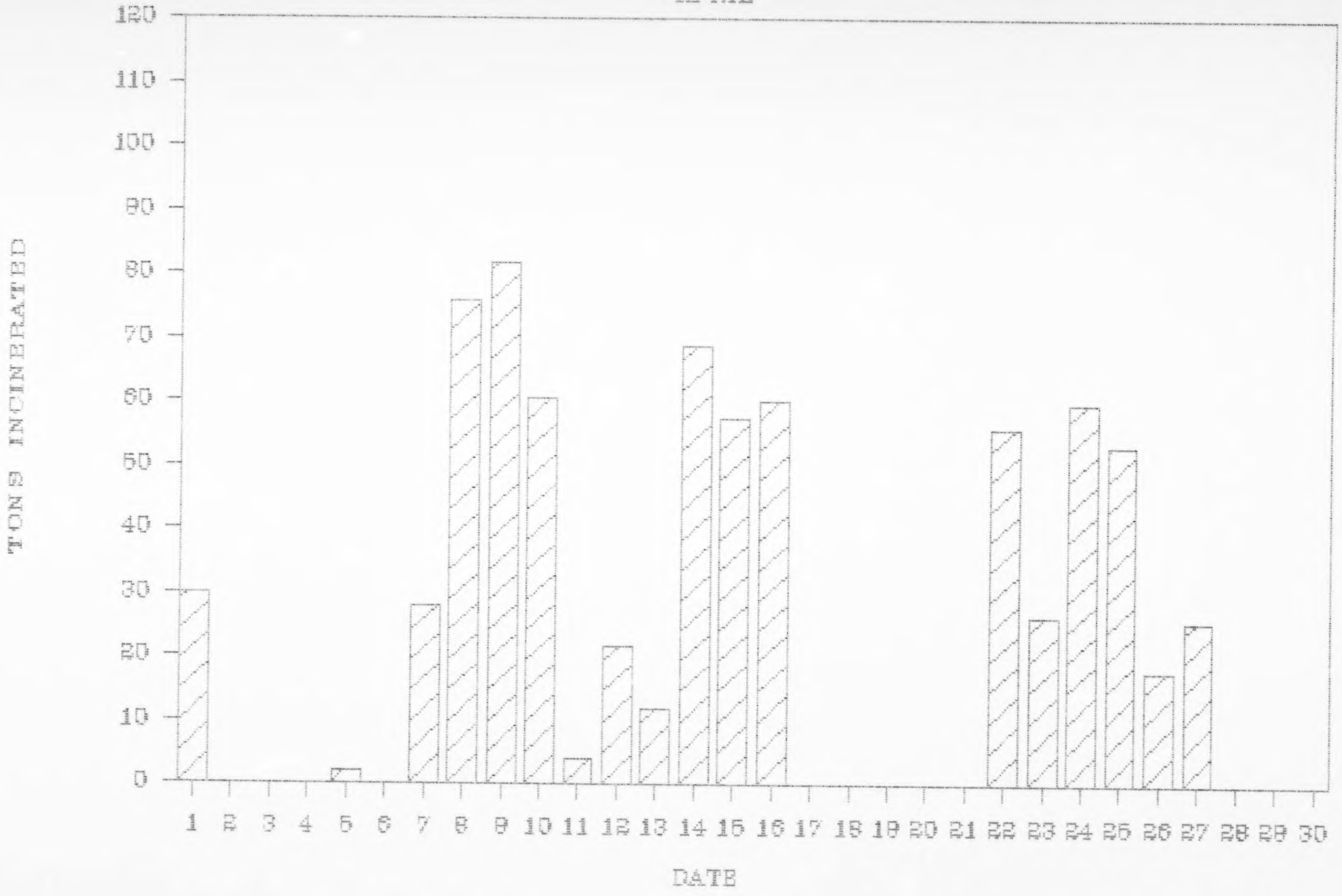
PEAK OIL-INCINERATION

MARCH



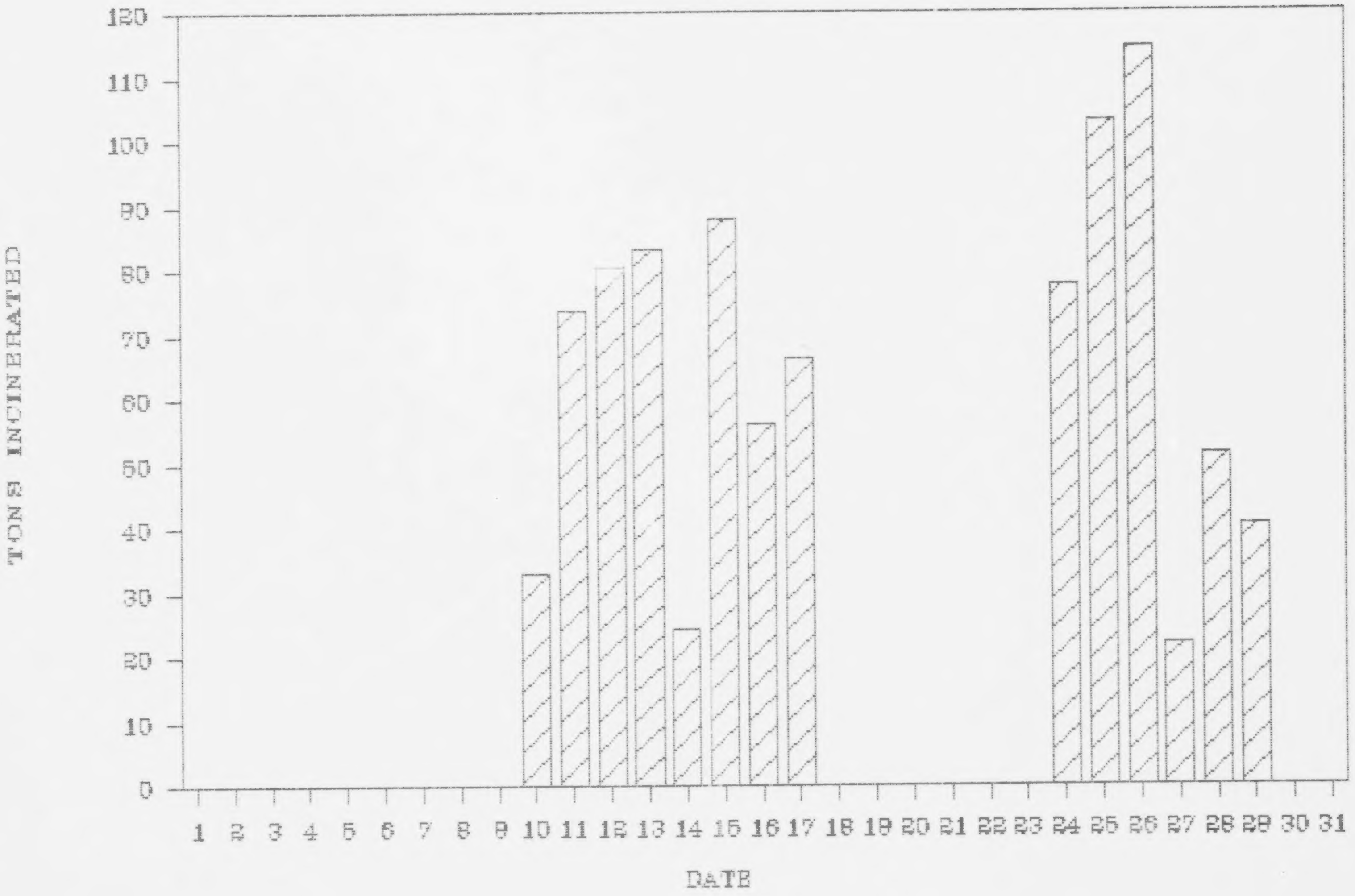
PEAK OIL–INCINERATION

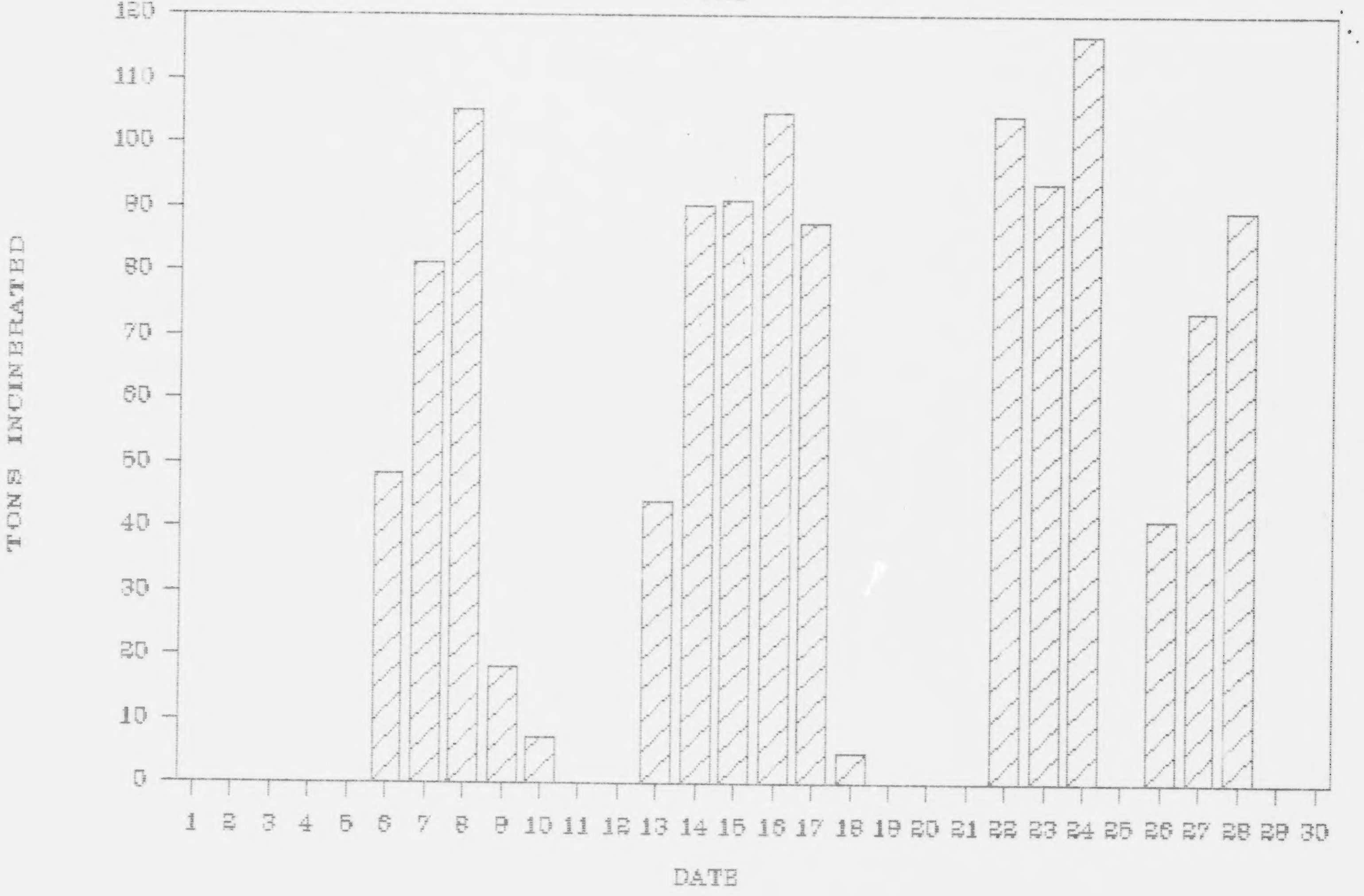
APRIL



PEAK OIL–INCINERATION

MAY



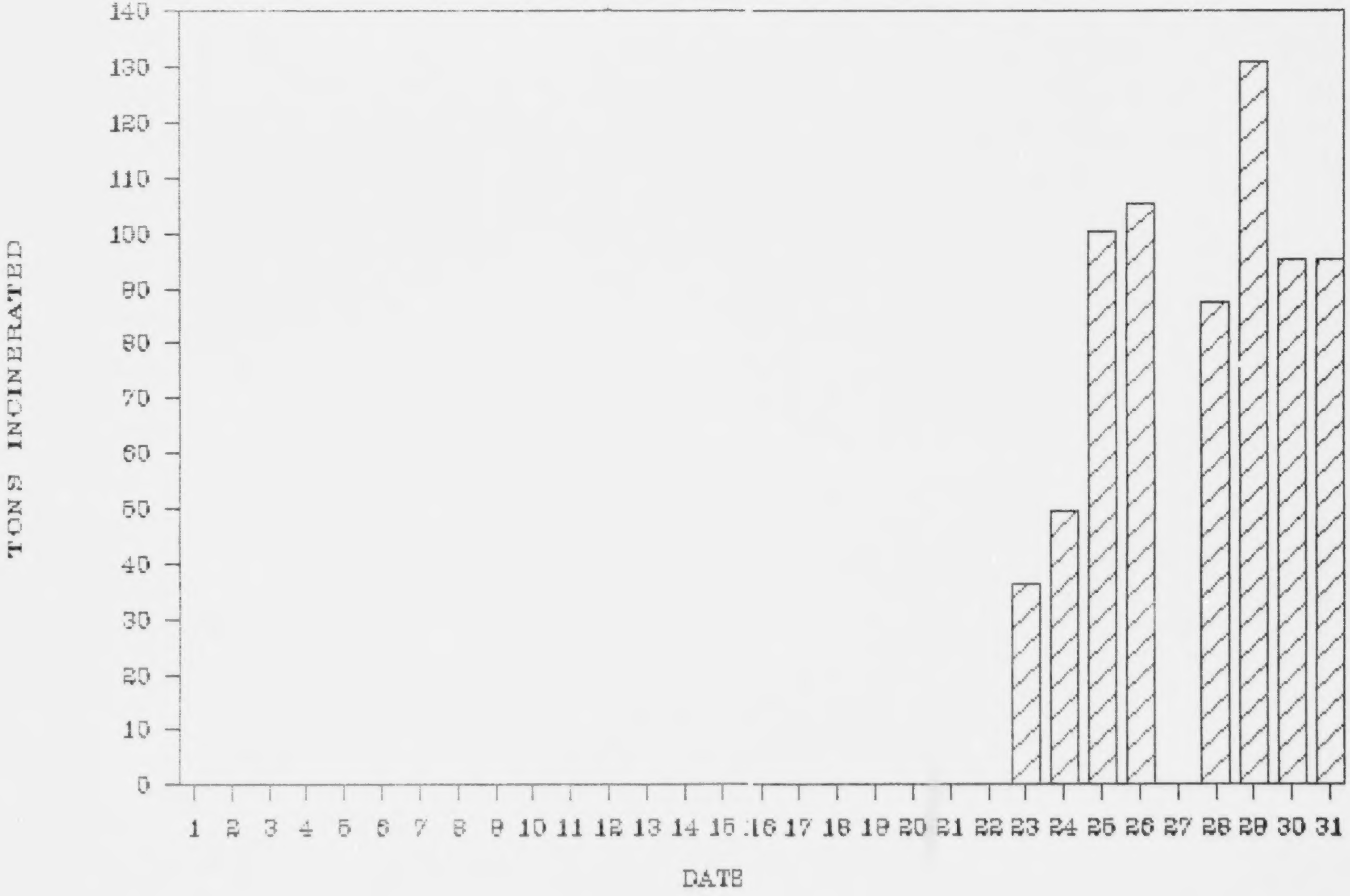


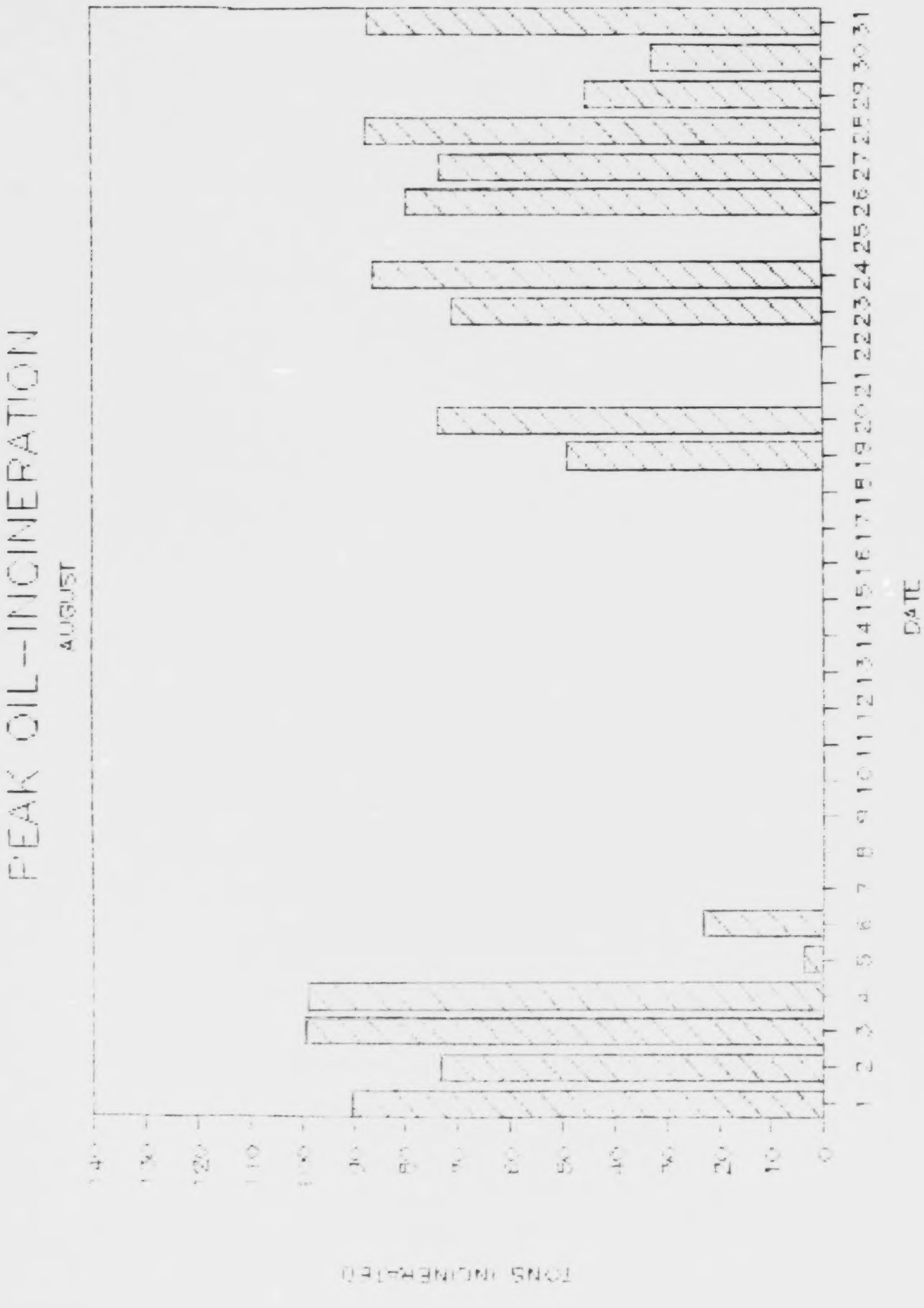
PEAK OIL-INCINERATION

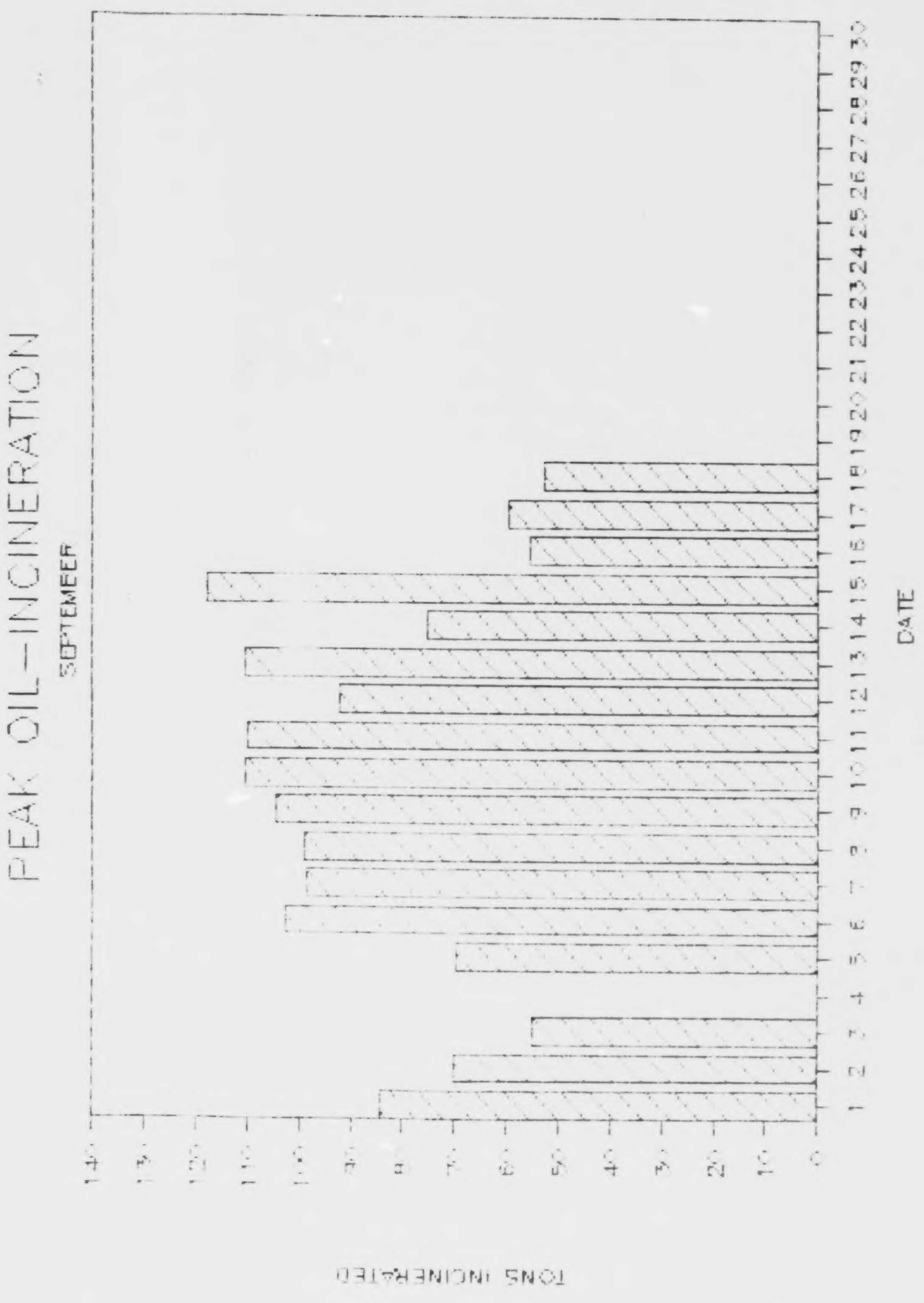
JUNE

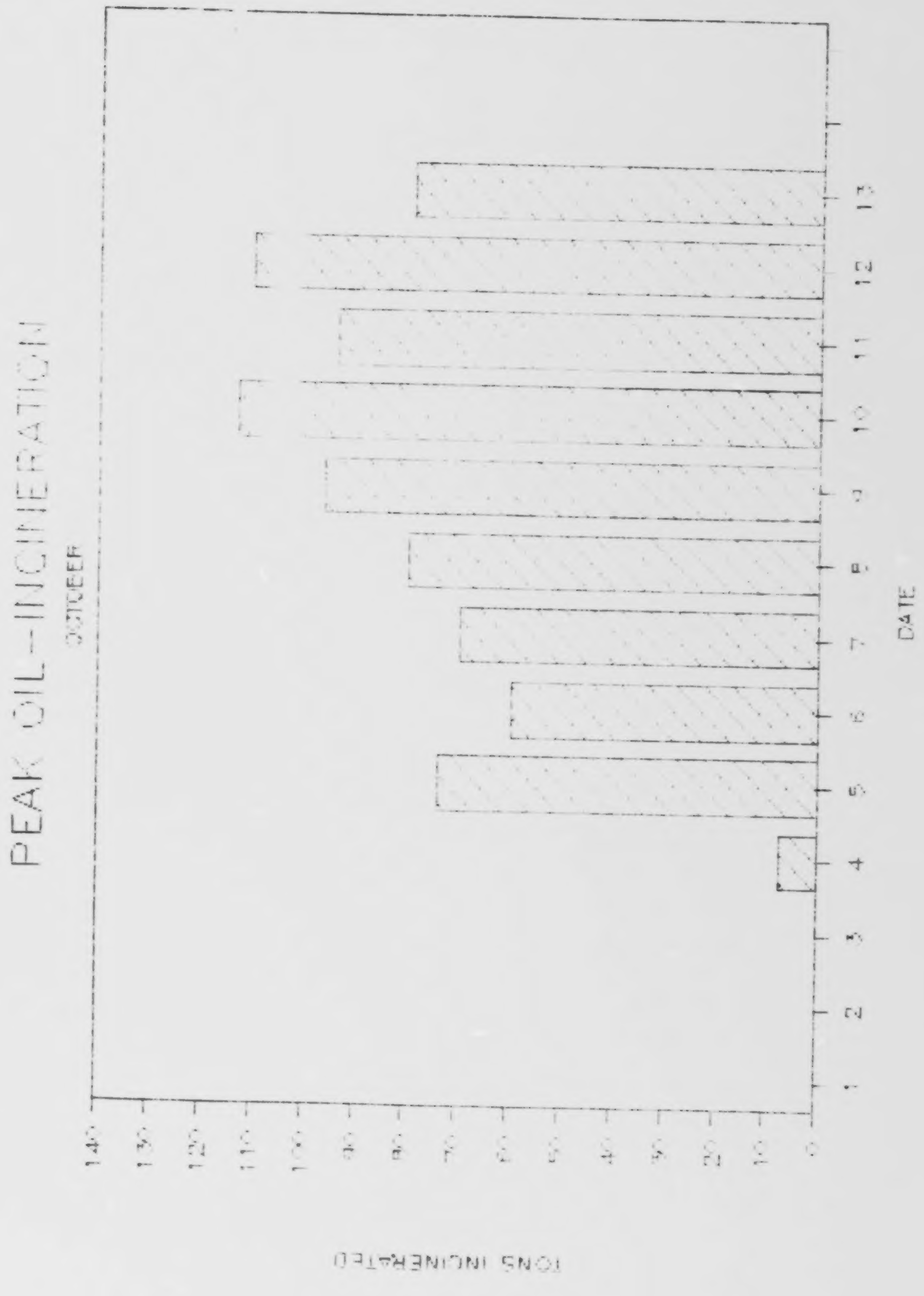
PEAK OIL-INCINERATION

JULY




PEAK OIL-INCINERATION
AUGUST
TONS INCINERATED
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
DATE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31


PEAK OIL—INCINERATION
SEPTEMBER
TONS INCINERATED
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
DATE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30


PEAK OIL-INCINERATION
OCTOBER
TONS INCINERATED
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
DATE

APPENDIX B

Sampling and Analytical Report

APPENDIX B

SAMPLING AND ANALYTICAL REPORT

Included herein is a copy of the Final Report, "Characterization of the Shirco Infrared Incineration System at the Peak Oil Site, Brandon, Florida," as prepared by Radian Corporation and dated April, 1988.

DCN 88-274-002-01

FINAL REPORT

CHARACTERIZATION OF THE SHIRCO INFRARED INCINERATION SYSTEM AT THE PEAK OIL SITE, BRANDON, FLORIDA

Submitted to:

Mr. Sy Rosenthal
Enviresponse, Inc.
GSA Raritan Depot
Building 209, Bay F
Edison, New Jersey 08837

Prepared by:

Radian Corporation
8501 Mo-Pac Boulevard
Post Office Box 201088
Austin, Texas 78720-1088

April 1988

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1-1

2.0 PRESENTATION OF RESULTS 2-1
  2.1 PCBs 2-1
  2.2 PCDD/PCDF 2-7
  2.3 Semi-Volatile Organics 2-7
  2.4 Volatile Organics 2-21
  2.5 Metals 2-21
  2.6 Stack Gas Measurements 2-31
  2.7 Solids Characterization 2-31
  2.8 Leachability Characteristics 2-37
  2.9 Wastewater Parameters 2-44

3.0 QUALITY ASSURANCE AND QUALITY CONTROL 3-1
  3.1 QA/QC Results for PCB Analyses 3-6
    3.1.1 Blank Sample Analyses 3-6
    3.1.2 Spiked Sample Analyses 3-6
  3.2 QA/QC Results for PCDD/PCDF Analyses 3-14
    3.2.1 Blank Sample Analyses 3-14
    3.2.2 Spiked Sample Analyses 3-15
  3.3 QA/QC Results for Semivolatile Organics Analyses 3-15
    3.3.1 Blank Sample Analyses 3-19
    3.3.2 Spiked Sample Analyses 3-19
  3.4 QA/QC Results for Volatile Organics Analyses 3-31
    3.4.1 Blank Sample Analyses 3-32
    3.4.2 Spiked Sample Analyses 3-32
  3.5 QA/QC Results for Metals Analyses 3-43
    3.5.1 Blank Sample Analyses 3-43
    3.5.2 Spiked Sample Analyses 3-44
    3.5.3 Duplicate Analyses 3-50
  3.6 QA/QC Results for Continuous Emission Monitors 3-50
  3.7 QA/QC Results for Solids Characterization 3-50

APPENDIX A - Trip Log A-1

1.0 INTRODUCTION

In an emergency response action, the United States Environmental Protection Agency (U.S. EPA) implemented a clean-up of the Peak Oil Superfund site in Brandon, Florida. Contaminated soil removed at the site was treated using a transportable infrared incineration system manufactured by Shirco Infrared Systems, Inc. The project was conducted by Haztech, Inc. beginning in November 1986 with the set-up of the Shirco unit. The site is known to be contaminated with PCBs (polychlorinated biphenyls) lead, and other metals.

The transportable incineration system used at Peak Oil consists of a Shirco infrared primary combustor, a secondary combustion chamber, and an air pollution control system. During the remediation effort at Peak Oil, a comprehensive sampling and analysis program was conducted to characterize emissions, effluents, and discharges from the process relative to characteristics of the waste feed and process operation. A schematic of the incineration system is shown in Figure 1-1 indicating stream sampling locations. This effort was conducted by Radian Corporation under contract to Enviresponse, Inc. and performed under the auspices of EPA's Superfund Innovative Technology Evaluation (SITE) program. The objective of the SITE program is to evaluate innovative technologies for suitability for the remediation of Superfund sites.

The sampling and analysis program at the Peak Oil site included a comprehensive characterization of all feed, emission, effluent, and discharge streams of the transportable infrared incineration system. Ambient air samples were also taken to evaluate ambient air concentrations of PCBs in the vicinity of the incinerator. Table 1-1 presents the streams sampled, the parameters measured in each stream, and the sampling and analytical protocols used to characterize the Shirco transportable incineration system. The sampling and analysis program was conducted according to a Quality Assurance Project Plan (QAPP) developed specifically for the Peak Oil program. That document "Quality Assurance Project Plan/Test Plan for the Haztech/Shirco

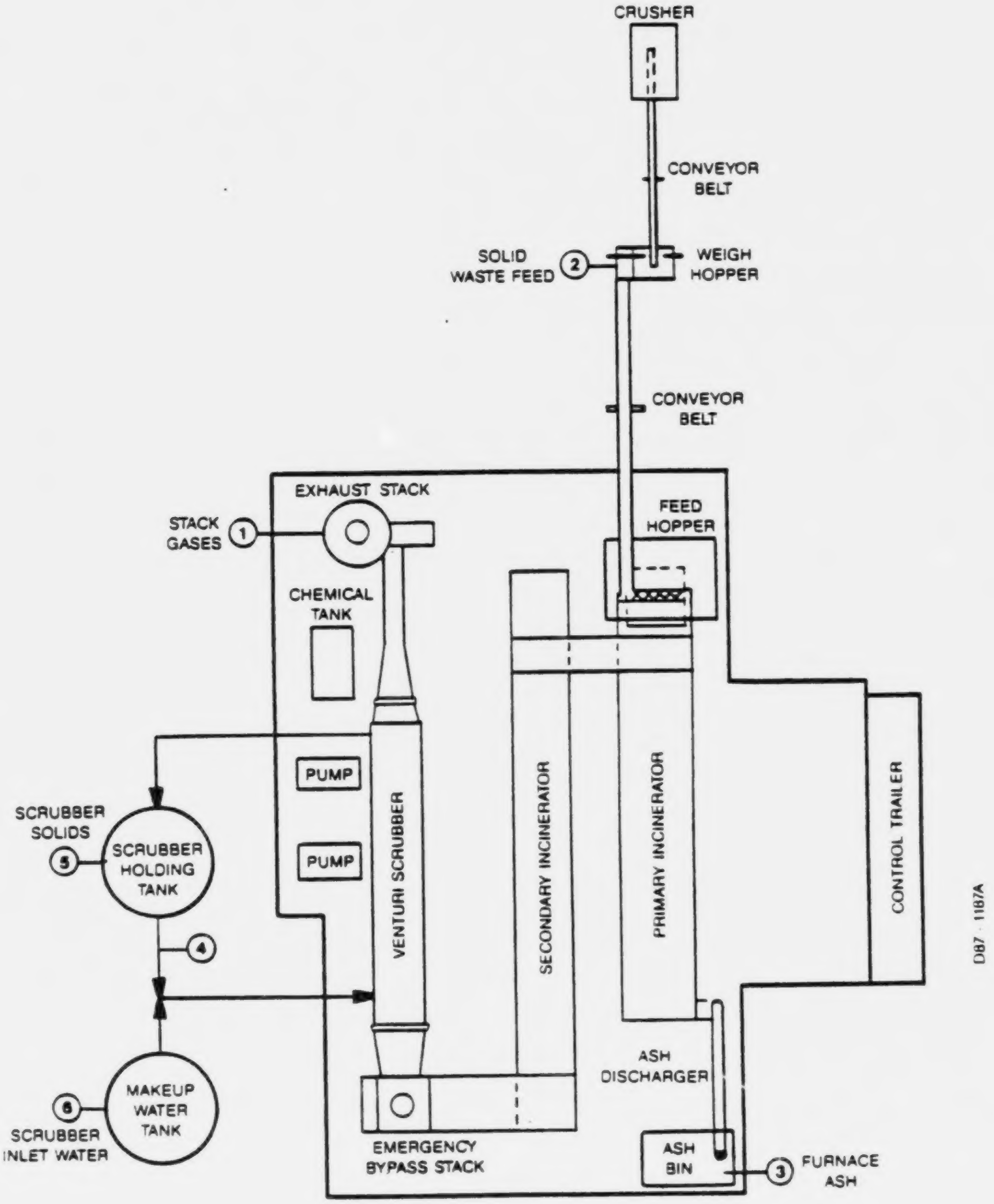

CRUSHER
CONVEYOR BELT
SOLID WASTE FEED
2
WEIGH HOPPER
CONVEYOR BELT
EXHAUST STACK
STACK GASES
1
FEED HOPPER
CHEMICAL TANK
PUMP
PUMP
SCRUBBER SOLIDS
5
SCRUBBER HOLDING TANK
4
VENTURI SCRUBBER
SECONDARY INCINERATOR
PRIMARY INCINERATOR
CONTROL TRAILER
D87 · 1187A
6
MAKEUP WATER TANK
SCRUBBER INLET WATER
EMERGENCY BYPASS STACK
ASH DISCHARGER
ASH BIN
3
FURNACE ASH

Figure 1-1. Schematic of the Haztech/Shirco Incinerator Indicating Sampling Locations

TABLE 1-1. SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR THE PEAK OIL SITE, BRANDON, FLORIDA

Source	Sample Collection Frequency	Sampling Method	Analysis Parameters	Analysis Method
Stack Gas	Composite over 3-6 hour period	EPA Method 5 with 0.1 N NaOH	Particulate Matter HCl Volumetric flowrate Moisture Metals (particulate on filter)	EPA Method 5 Ion Chromatography EPA Methods 1-4 EPA Method 4 SW 6010, 7060, 7041, 7421, 7740, 7470/7471
	Composite over 3-6 hour period	SASS with XAD-2 (SW0020)	PCB	EPA 680
	Composites over 3-6 hour period	SASS with XAD-2 (SW0020)	PCDD/PCDF Semi-volatile Priority Pollutants (plus 10 highest peaks)	SW 8280 SW 8270
	Composite over 4 hour period	Modified Method 5 (No filter/0.1 N NaOH)	Soluble Chromium	M218.4
		Gas Bag (Grab)	CO_2, O_2	EPA Method 3
	6 pairs of samples over 2 hour period (one aqueous condensate)	VOST (SW0030)	Volatile Priority Pollutants (plus 10 highest peaks)	SW 8240
	Continuous	Continuous emission monitors	O_2 CO_2 CO THC NO_x	Paramagnetic NDIR NDIR FID Chemiluminescence
Solid Waste Feed	Grab sample once per hour and composite	S007	PCB PCDD/PCDF Metals	EPA 680 SW 8280 SW 6010, 7060, 7041, 7421, 7740, 7470/7471
			EP Toxicity TCLP (Proposed) Volatile Priority Pollutants (plus 10 highest peaks)	C004, SW 1310 Fed.Reg. Vol. 51, No. 114 SW 8240
			Semi-volatile Priority Pollutants (plus 10 highest peaks)	SW 8270
			Total Chromatographable Organics (TCO) Gravimetric (GRAV) HHV Ultimate Moisture, Ash Chlorine	A011 A012 A006 A003 A001 A003

(Continued)

TABLE 1-1. (Continued)

Source	Sample Collection Frequency	Sampling Method	Analysis Parameters	Analysis Method
Furnace Ash	Grab sample once per hour and composite	S007	PCB	EPA 680
			PCDD/PCDF	SW8280
			Metals	SW 6010, 7060, 7041 7421, 7740, 7470/7471
			EP Toxicity	C004, SW 1310
			TCLP (Proposed)	Fed. Reg. Vol. 51, No. 114
			Volatile Priority Pollutants (plus 10 highest peaks	SW 8240
			Semi-volatile Priority Pollutants (plus 10 highest peaks)	SW 8270
			Total Chromatographable Organics (TCO)	A011
			Gravimetric (GRAV)	A012
			Moisture, Ash	A001
			Chlorine	A003
Scrubber Liquid Effluent	Grab sample once per hour and composite	S004	PCB	EPA 680
			PCDD/PCDF	EPA 8280
			pH	M150.1
			Chloride	Ion Chromatography
			Metals	SW 6010, 7060, 7041, 7421, 7740, 7470/7471
			EP Toxicity	C004, SW 1310
			TCLP (Proposed)	Fed Reg. Vol. 51, No. 114
			Volatile Priority Pollutants (plus 10 highest peaks)	SW 8240
			Semi-volatile Priority Pollutants (plus 10 highest peaks)	SW 8270
			Total Organic Carbon	M415.1
			Total Suspended Solids	M160.1
			Total Dissolved Solids	M160.2
Scrubber Solids	Grab sample once per hour and composite	S007	PCB	EPA 680
			PCDD/PCDF	SW8280
			Metals	SW 6010, 7060, 7041 7421, 7740, 7470/7471
			EP Toxicity	C004, SW 1310
			TCLP (Proposed)	Fed. Reg. Vol. 51, No. 114
			Volatile Priority Pollutants (plus 10 highest peaks)	SW 8240

(Continued)

TABLE 1-1. (Continued)

Source	Sample Collection Frequency	Sampling Method	Analysis Parameters	Analysis Method
Scrubber Solids (Continued)			Semi-volatile Priority Pollutants (plus 10 highest peaks)	SW 8270
			HHV	A006
			Moisture, Ash	A001
			Ultimate	A003
			Chlorine	A003
Scrubber Water Make-up	One sample	S004	PCB	EPA 680
			PCDD/PCDF	EPA 8280
			pH	M150.1
			Chloride	Ion Chromatography
			Metals	SW 6010, 7060, 7041, 7421, 7740, 7470/7471
			Volatile Priority Pollutants (plus 10 highest peaks)	SW 8240
			Semi-volatile Priority Pollutants (plus 10 highest peaks)	SW 8270
			Total Organic Carbon	M415.1
			Total Suspended Solids	M160.1
			Total Dissolved Solids	M160.2
Ambient Air	Continuous over 24-hour period; One upwind and one downwind	General Metal Works Model PS-1 Air Sampler with polyurethane foam (PUF) plugs and florisil sorbent	PCB	EPA 680

S-, A- Methods from Arthur D. Little, Inc., "Sampling and Analysis Methods for Hazardous Waste Combustions", EAP 600/8-84-002, PB84-155845, February, 1984.

EPA Method from Code of Federal Regulations 40 CFR Part 60, Appendix A, Revised as of July 1, 1985.

M - Methods from U.S. EPA "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, March, 1979.

SW - Methods from U.S. EPA "Test Methods for Evaluating Solid Waste-Physical/Chemical Methods", SW-846, Third Edition 1986.

SASS - Method from U.S. EPA "Modified Method 5 Train and Source Assessment Sampling System Operator's Manual", EPA-600/8-85-003, February, 1985.

EPA - Method from U.S. EPA "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater", EPA-600/4-82-057.

Incinerator at the Peak Oil Site in Brandon, Florida" (10 August 1987) delineates in detail the sampling and analytical protocols followed in the characterization of the infrared incineration system. The characterization effort was performed using the protocols of the third edition of "Test Methods for Evaluating Solid Waste" (SW-846) where applicable, other EPA-approved procedures, and state-of-the-art techniques.

The testing program at Peak Oil was conducted over four days, from August 1 through August 4, 1987. During that period all process streams were sampled in triplicate for the parameters in Table 1-1. Scrubber make-up water was sampled once at the conclusion of the effort to evaluate the potential for scrubber contamination by that stream. In addition to the triplicate measurements, the test parameters were measured in duplicate during one of the tests. That test (conducted on August 3 and 4) required two days to complete due to the additional time necessary to collect stack gas samples. The data presented in this report are presented for the three measurement periods: 8/1, 8/2, and 8/3&4. Note that the duplicate test is denoted as 8/3&4D.

This report presents the results of the characterization of the infrared incineration system at the Peak Oil site. The data are presented in Section 2, Data Presentation. Quality Assurance/Quality Control results are presented in Section 3.

The trip log presented in Appendix A documents the events that took place while the Radian field crew was on the Peak Oil site. The log chronicles the testing times, climate interferences, process upsets, and general proceedings involving the Radian field crew.

2.0 PRESENTATION OF RESULTS

This section presents the results of the characterization of the Shirco transportable, infrared incineration system operated at the Peak Oil Superfund site. The results are presented by parameter or type of characterization.

2.1 PCBs

Polychlorinated biphenyls (PCBs) were measured in the solid waste feed, kiln ash, scrubber solids, stack gas, scrubber water effluent, and scrubber make-up water. Analysis of PCBs was performed using EPA Method 680 which involves solvent extraction followed by GC/MS (gas chromatography/mass spectroscopy) analysis.

Solid waste feed, scrubber solids, and kiln ash results for PCBs are presented in Table 2-1. PCB results for the stack gas are shown in Table 2-2, and the liquid streams (scrubber effluent water and scrubber make-up water) PCB data are presented in Table 2-3.

As seen in Table 2-1, dichloro- through heptachlorobiphenyls were quantified in the solid waste feed, and trichloro- through heptachlorobiphenyls were quantified in the kiln ash. Monochloro- through heptachlorobiphenyls were identified in the the stack gas. No PCBs were quantified in the scrubber solids or waters.

Ambient concentrations of PCBs were also measured daily at two locations, one generally upwind and one generally downwind. Wind direction was not monitored during the test, but southwest winds were prevalent. Samples were collected over 24 hours. Figure 2-1 identifies the two ambient air, "upwind" and "downwind" sampling locations at the Peak Oil site. Table 2-4 presents the measured ambient air concentrations of PCBs.

TABLE 2-1. RESULTS OF PCB ANALYSIS ON SOLIDS STREAMS

	Solid Waste Feed			
	8/1 (ng/g)	8/2 (ng/g)	8/3-4 (ng/g)	8/3-4D (ng/g)
Monochlorobiphenyl	<60	<50	<50	<40
Dichlorobiphenyl	160	120	190	130
Trichlorobiphenyl	820	720	780	570
Tetrachlorobiphenyl	790	440	830	440
Pentachlorobiphenyl	310	270	490	200
Hexachlorobiphenyl	1700	1100	1600	1300
Heptachlorobiphenyl	2200	1300	1600	940
Octachlorobiphenyl	<60	<50	<50	45
Nonachlorobiphenyl	<60	<50	<50	<40
Decachlorobiphenyl	<60	<50	<50	<40
Total PCB[a]	5850	3850	5340	3480

	Scrubber Solids				
	8/1 (ng/g)	8/2 (ng/g)	8/3-4 (ng/g)	8/3-4D (ng/g)	Blank (ng/g)
Monochlorobiphenyl	<2	<2	<2	<2	<2
Dichlorobiphenyl	<2	<2	<2	<2	<2
Trichlorobiphenyl	<2	<2	<2	<2	<2
Tetrachlorobiphenyl	<2	<2	<2	<2	<2
Pentachlorobiphenyl	<2	<2	<2	<2	<2
Hexachlorobiphenyl	<2	<2	<2	<2	<2
Heptachlorobiphenyl	<2	<2	<2	<2	<2
Octachlorobiphenyl	<2	<2	<2	<2	<2
Nonachlorobiphenyl	<2	<2	<2	<2	<2
Decachlorobiphenyl	<2	<2	<2	<2	<2
Total PCB[a]	0	0	0	0	0

	Furnace Ash				
	8/1 (ng/g)	8/2 (ng/g)	8/3-4 (ng/g)	8/3-4D (ng/g)	Blank (ng/g)
Monochlorobiphenyl	<2	<2	<2	<2	<2
Dichlorobiphenyl	<2	<2	<2	<2	<2
Trichlorobiphenyl	<2	<2	61	28	<2
Tetrachlorobiphenyl	<2	22	120	63	<2
Pentachlorobiphenyl	<2	16	42	46	<2
Hexachlorobiphenyl	7	112	400	185	<2
Heptachlorobiphenyl	<2	89	280	213	<2
Octachlorobiphenyl	<2	<2	<2	<2	<2
Nonachlorobiphenyl	<2	<2	<2	<2	<2
Decachlorobiphenyl	<2	<2	<2	<2	<2
Total PCB[a]	7	240	900	540	0

[a] Total PCB calculated corrected according to 40 CFR 761.3.

TABLE 2-2. RESULTS OF PCB ANALYSIS OF STACK GAS

	8/1			8/2		
	1430-1920			1100-1615		
Sample Volume (SCF):	258.3			425.6		
Stack Gas Flow (DSCFM):	5520			4670		
Analyte	Mass Detected (ng)	Stack Gas Conc. (ug/m^3)	MER (ug/hr)	Mass Detected (ng)	Stack Gas Conc. (ug/m^3)	MER (ug/hr)
Monochlorobiphenyl	<20	<0.0027	<25.6	<20	<0.0017	<13.2
Dichlorobiphenyl	<20	<0.0027	<25.6	<20	<0.0017	<13.2
Trichlorobiphenyl	45	0.0062	57.7	26	0.0022	17.1
Tetrachlorobiphenyl	<20	<0.0027	<25.6	74	0.0061	48.7
Pentachlorobiphenyl	<20	<0.0027	<25.6	<20	<0.0017	<13.2
Hexachlorobiphenyl	<20	<0.0027	<25.6	120	0.0100	79.0
Heptachlorobiphenyl	<20	<0.0027	<25.6	45	0.0037	29.6
Octachlorobiphenyl	<20	<0.0027	<25.6	<20	<0.0017	<13.2
Nonachlorobiphenyl	<20	<0.0027	<25.6	<20	<0.0017	<13.2
Decachlorobiphenyl	<20	<0.0027	<25.6	<20	<0.0017	<13.2
Total PCBs([a])	45	0.0062	57.7	265	0.0220	174.4

	8/3			8/3 DUP		
	1015-1550			1015-1550		
Sample Volume (SCF):	298.4			353.7		
Stack Gas Flow (DSCFM):	4900			5390		
Analyte	Mass Detected (ng)	Stack Gas Conc. (ug/m^3)	MER (ug/hr)	Mass Detected (ng)	Stack Gas Conc. (ug/m^3)	MER (ug/hr)
Monochlorobiphenyl	39	0.0046	38.4	40	0.0040	36.6
Dichlorobiphenyl	<20	<0.0024	<19.7	<20	<0.0020	<18.3
Trichlorobiphenyl	58	0.0069	57.1	76	0.0076	69.5
Tetrachlorobiphenyl	<20	<0.0024	<19.7	61	0.0061	55.8
Pentachlorobiphenyl	<20	<0.0024	<19.7	<20	<0.0020	<18.3
Hexachlorobiphenyl	<20	<0.0024	<19.7	<20	<0.0020	<18.3
Heptachlorobiphenyl	<20	<0.0024	<19.7	<20	<0.0020	<18.3
Octachlorobiphenyl	<20	<0.0024	<19.7	<20	<0.0020	<18.3
Nonachlorobiphenyl	<20	<0.0024	<19.7	<20	<0.0020	<18.3
Decachlorobiphenyl	<20	<0.0024	<19.7	<20	<0.0020	<18.3
Total PCBs([a])	59	0.0070	57.9	138	0.0138	126.0

[a] Corrected according to 40 CFR 761.3.

TABLE 2-3. RESULTS OF PCB ANALYSIS ON SCRUBBER EFFLUENT AND MAKE-UP WATER

	Scrubber Effluent				Make-up	
	8/1 (ng/mL)	8/2 (ng/mL)	8/3-4 (ng/mL)	8/3-4D[a] (ng/mL)	Water (ng/mL)	Blank (ng/mL)
Monochlorobiphenyl	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichlorobiphenyl	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Trichlorobiphenyl	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tetrachlorobiphenyl	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Pentachlorobiphenyl	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Hexachlorobiphenyl	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Heptachlorobiphenyl	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Octachlorobiphenyl	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nonachlorobiphenyl	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Decachlorobiphenyl	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

[a] There was no recovery of surrogates.

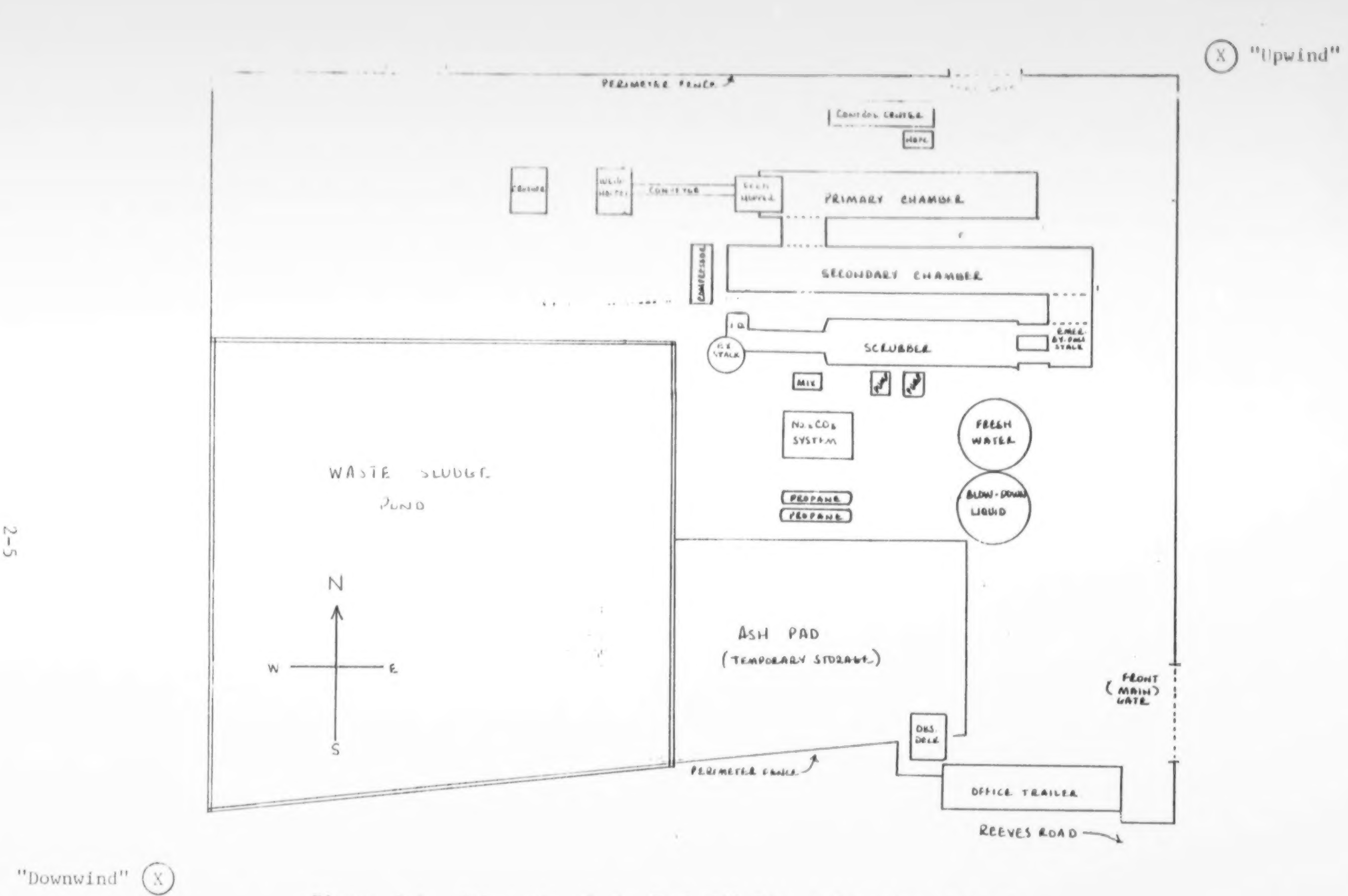

(X) "Upwind"
PERIMETER FENCE
CONTROL CENTER
PRIMARY CHAMBER
SECONDARY CHAMBER
CONVEYOR
FEED HOPPER
COMPRESSOR
I.D.
STACK
SCRUBBER
EMERGENCY STACK
MIX
Na₂CO₃ SYSTEM
FRESH WATER
BLOW-DOWN LIQUID
PROPANE
PROPANE
WASTE SLUDGE POND
N
W
E
S
ASH PAD
(TEMPORARY STORAGE)
FRONT (MAIN) GATE
PERIMETER FENCE
OFFICE TRAILER
REEVES ROAD
"Downwind" (X)

Figure 2-1. Schematic of the Peak Oil Site Indicating Ambient Air Sampling Locations

TABLE 2-4. RESULTS OF PCB ANALYSIS ON AMBIENT AIR

Date:	7/31		7/31			8/1		8/1			8/2	
Location:	Upwind		Downwind			Upwind		Downwind			Upwind	
Sample Volume (M^3):	261		249			241		229			220	
Parameter	Mass Collected (ng)	Gas Phase Concentration (ng/M^3)	Mass Collected (ng)	Gas Phase Concentration (ng/M^3)	7/31 Blank (ng)	Mass Collected (ng)	Gas Phase Concentration (ng/M^3)	Mass Collected (ng)	Gas Phase Concentration (ng/M^3)	8/1 Blank (ng)	Mass Collected (ng)	Gas Phase Concentration (ng/M^3)
Monochlorobiphenyl	<20	<0.08	<20	<0.08	<20	<20	<0.08	240	1.05	<20	290	1.32
Dichlorobiphenyl	<20	<0.08	<20	<0.08	<20	<20	<0.08	42	0.18	<20	71	0.32
Trichlorobiphenyl	<20	<0.08	4800	19.25	<20	670	2.78	2600	11.38	<20	2700	12.28
Tetrachlorobiphenyl	220	0.84	4600	18.45	<20	1000	4.14	2300	10.06	<20	2200	9.99
Pentachlorobiphenyl	<20	<0.08	1500	6.02	<20	<20	<0.08	1100	4.81	<20	640	2.91
Hexachlorobiphenyl	170	0.65	4000	16.04	<20	280	1.16	1600	7.00	<20	1800	8.17
Heptachlorobiphenyl	<20	<0.08	1600	6.42	<20	140	0.58	570	2.49	<20	650	2.95
Octachlorobiphenyl	<20	<0.08	78	0.31	<20	<20	<0.08	<20	<0.09	<20	<20	<0.09
Nonachlorobiphenyl	<20	<0.08	<20	<0.08	<20	<20	<0.08	<20	<0.09	<20	<20	<0.09
Decachlorobiphenyl	<20	<0.08	<20	<0.08	<20	<20	<0.08	<20	<0.09	<20	<20	<0.09

Date:	8/2		8/3		8/3		8/4		8/4	
Location:	Downwind		Upwind		Downwind		Upwind		Downwind	
Sample Volume (M^3):	266		252		233		236		217	
Parameter	Mass Collected (ng)	Gas Phase Concentration (ng/M^3)	Mass Collected (ng)	Gas Phase Concentration (ng/M^3)	Mass Collected (ng)	Gas Phase Concentration (ng/M^3)	Mass Collected (ng)	Gas Phase Concentration (ng/M^3)	Mass Collected (ng)	Gas Phase Concentration (ng/M^3)
Monochlorobiphenyl	<20	<0.08	<20	<0.08	340	1.46	<20	<0.08	380	1.75
Dichlorobiphenyl	<20	<0.08	<20	<0.08	97	0.42	<20	<0.08	<20	<0.09
Trichlorobiphenyl	72	0.27	61	0.24	1800	7.72	<20	<0.08	3460	15.96
Tetrachlorobiphenyl	92	0.35	35	0.14	2700	11.58	<20	<0.08	3270	15.09
Pentachlorobiphenyl	<23	<0.09	<20	<0.08	600	2.57	<20	<0.08	1260	5.81
Hexachlorobiphenyl	110	0.41	146	0.58	1400	6.01	87	0.37	3060	14.12
Heptachlorobiphenyl	<20	<0.08	65	0.26	420	1.80	<20	<0.08	1100	5.08
Octachlorobiphenyl	<20	<0.08	<20	<0.08	<20	<0.09	<20	<0.08	<20	<0.09
Nonachlorobiphenyl	<20	<0.08	<20	<0.08	<20	<0.09	<20	<0.08	<20	<0.09
Decachlorobiphenyl	<20	<0.08	<20	<0.08	<20	<0.09	<20	<0.08	<20	<0.09

2.2 PCDD/PCDF

Solid waste feed, scrubber solids, kiln ash, stack gas, scrubber effluent water, and scrubber make-up water were analyzed for polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Analysis was performed according to Method 8280 of SW-846, 3rd edition. PCDD/PCDF results of the solids streams are presented in Table 2-5. Stack gas PCDD/PCDF results are shown in Table 2-6, and PCDD/PCDF results for the scrubber waters are in Table 2-7.

No PCDDs were quantified in any stream above the detection limit. PCDF was quantified in one sample. A low level concentration of tetrachlorodibenzofuran was measured in the 2 August stack gas sample.

Note that PCDD/PCDF and semi-volatile organics were analyzed in the same SASS train samples. The solvent extracts were halved with the respective analyses performed on one-half of the sample. Therefore, one-half of the sample gas volume is related to PCDD/PCDF and semi-volatile organics analytical results.

2.3 Semi-Volatile Organics

As for PCBs and PCDD/PCDF, all sampled streams were analyzed for semi-volatile organics. Method 8270 of SW-846, 3rd edition was used to analyze for the Appendix IX compounds. The target analytes are listed in the data tables.

Table 2-8 presents the semi-volatile organics analytical results for the solids streams. Table 2-9 contains the stack gas semi-volatile organics data, and the liquids data are in Table 2-10.

TABLE 2-5. RESULTS OF DIOXIN/FURAN ANALYSES ON SOLIDS STREAMS

	Solid Waste Feed			
	8/1 (ng/g)	8/2 (ng/g)	8/3-4 (ng/g)	8/3-4D (ng/g)
Total TCDD	<1.1	<0.6	<0.8	<2
Total TCDF	<0.6	<0.5	<0.6	<1
Total PCDD	<0.9	<0.6	<0.7	<1
Total PCDF	<0.8	<0.6	<0.6	<1
Total HxCDD	NA[a]	<1.3	<4.5	NA[a]
Total HxCDF	NA[a]	<1.4	<2.8	NA[a]

	Scrubber Solids			
	8/1 (ng/g)	8/2 (ng/g)	8/3-4 (ng/g)	8/3-4D (ng/g)
Total TCDD	<0.2	NA[a]	<0.2	<0.1
Total TCDF	<0.1	NA[a]	<0.1	<0.1
Total PCDD	<0.9[a]	NA[a]	<0.6[a]	<0.9[a]
Total PCDF	<1.1[a]	NA[a]	NA[a]	<1.0[a]
Total HxCDD	<1.5[a]	NA[a]	<1.1[a]	<2.1[a]
Total HxCDF	NA[a]	NA[a]	NA[a]	NA[a]

	Furnace Ash				Reagent Blank
	8/1 (ng/g)	8/2 (ng/g)	8/3-4 (ng/g)	8/3-4D (ng/g)	(ng/g)
Total TCDD	<0.7	<1.4	<0.8	<0.6	<0.2
Total TCDF	<0.4	<1.0	<0.6	<0.4	<0.1
Total PCDD	<0.7	<1.1	<0.7	<0.5	<0.1
Total PCDF	<0.7	<1.1	<0.6	<0.8	<0.1
Total HxCDD	NA[a]	<1.8[a]	<1.4	<0.6	<0.2
Total HxCDF	<2.0	<2.1	<1.6	<0.8	<0.1

NA = Not available; surrogate not recovered.

[a] Surrogate recovery outside of QA acceptance limits.

TABLE 2-6. RESULTS OF PCDD/PCDF ANALYSIS OF STACK GAS

Sample Volume (SCF): Stack Gas Flow (DSCFM):	8/1 2121-0130 136.65 5370		8/2 1800-2211 156.3 4570		8/4 0930-1445 143.2 4140		8/4 DUP 0930-1445 150.1 4690	
	Mass Detected (ng)	Stack Gas Conc, (ng/m^3)	Mass Detected (ng)	Stack Gas Conc, (ng/m^3)	Mass Detected (ng)	Stack Gas Conc, (ng/m^3)	Mass Detected (ng)	Stack Gas Conc, (ng/m^3)
Total TCDD	<0.6	<0.1550	<1.5	<0.3389	<1	<0.2466	<1	<0.2352
Total TCDF	<0.4	<0.1034	2.1	0.4744	<0.8	<0.1973	<1	<0.2352
Total PCDD	<0.6	<0.1550	<1	<0.2259	<1	<0.2466	<1	<0.2352
Total PCDF	<0.5	<0.1292	<0.8	<0.1807	<0.8	<0.1973	<1	<0.2352
Total HxCDD	<1.1	<0.2842	<1.6	<0.3615	<1.5	<0.3699	<2	<0.4705
Total HxCDF	<0.8	<0.2067	<2.5	<0.5648	<1.3	<0.3206	<2	<0.4705

TABLE 2-7. RESULTS OF DIOXIN/FURAN RESULTS ON SCRUBBER AND MAKE-UP WATER SAMPLES

Analyte	Scrubber Water 8/1 (ng/mL)	8/2 (ng/mL)	8/3-4 (ng/mL)	8/3-4D (ng/mL)	Make-up water (ng/mL)	Blank (ng/mL)
Total TCDD	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002
Total TCDF	<0.002	<0.001	<0.002	<0.001	<0.001	<0.001
Total PCDD	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002
Total PCDF	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total HxCDD	<0.004	<0.003	<0.005	<0.004	<0.003	<0.002
Total HxCDF	<0.003	<0.003	<0.004	<0.004	<0.007	<0.002[a]

[a] Surrogate recovery outside of QA acceptance limits.

TABLE 2-8. RESULTS OF SEMI-VOLATILE ORGANICS ANALYSES ON SOLIDS STREAMS

Parameter	Detection Limit (ug/g)	Solid Waste Feed				Scrubber Solids				Furnace Ash			
		8/1[a] (ug/g)	8/2[a] (ug/g)	8/3-4[a] (ug/g)	8/3-4D[a] (ug/g)	8/1 (ug/g)	8/2 (ug/g)	8/3-4 (ug/g)	8/3-4D (ug/g)	8/1 (ug/g)	8/2 (ug/g)	8/3-4 (ug/g)	8/3-4D (ug/g)
Acenaphthalene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	0.20	19	<10	<10	12	ND	ND	ND	ND	ND	ND	ND	ND
Acetophenone	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
2-Acetylaminofluorene	5.0	<25	<250	<250	<25	ND	ND	ND	ND	ND	ND	ND	ND
4-Aminobiphenyl	5.0	<25	<250	<250	<25	ND	ND	ND	ND	ND	ND	ND	ND
Aniline	0.40	<2.0	<20	<20	<2.0	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	0.20	19	<10	<10	41	ND	ND	ND	ND	ND	ND	ND	ND
Aramite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benz(a)anthracene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Benzenethiol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzidine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	0.20	30	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.20	20	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	4.4	ND
Benzo(gh,h,i)perylene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
p-Benzoquinone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzyl alcohol	0.40	<2.0	<20	<20	<2.0	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethoxy)ethane	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl)ether	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl)ether	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	0.20	<1.0	<10	<10	<1.0	2.0	ND	ND	ND	ND	14	ND	ND
4-Bromophenyl phenyl ether	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
2-Sec-butyl-4,6-dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Chloroaniline	4.0	<20	<200	<200	<20	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzilate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chloroethyl vinyl ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Chloro-m-cresol	0.20	<1.0	<10	<10	<1.0	2.4	ND	ND	ND	ND	3.8	ND	ND
2-Chloronaphthalene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	0.20	38	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	5.1	5.4
o-Cresol	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
p-Cresol	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,e)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	0.20	<1.0	<10	<10	10	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)pyrene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,i)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	0.[illegible]	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	0.40	<2.0	<20	<20	<2.0	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dichlorophenol	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND

(Continued)

TABLE 2-8. (Continued)

Parameter	Detection Limit (ug/g)	Solid Waste Feed 8/1 (ug/g)	Solid Waste Feed 8/2 (ug/g)	Solid Waste Feed 8/3-4 (ug/g)	Solid Waste Feed 8/3-4D (ug/g)	Scrubber Solids 8/1 (ug/g)	Scrubber Solids 8/2 (ug/g)	Scrubber Solids 8/3-4 (ug/g)	Scrubber Solids 8/3-4D (ug/g)	Furnace Ash 8/1 (ug/g)	Furnace Ash 8/2 (ug/g)	Furnace Ash 8/3-4 (ug/g)	Furnace Ash 8/3-4D (ug/g)
Diethylphthalate	0.20	10	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
p-Dimethylaminoazobenzene	5.0	<25	<250	<250	<25	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dimethoxybenzidine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
7,12-Dimethylbenz(a)anthracene	0.40	<2.0	<20	<20	<2.0	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dimethylbenzidine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
2,2-Dimethylphenethylamine	5.0	<25	<250	<250	<25	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	0.20	<1.0	<10	<10	<1.0	10	8.7	5.4	4.3	ND	ND	ND	ND
1,4-Dinitrobenzene	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-o-cresol	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	94	ND	ND	ND	ND
Di-n-octylphthalate	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-propylnitrosamine	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Diphenylamine	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Diphenylhydrazine	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	0.20	<1.0	<10	<10	17	ND	ND	ND	ND	ND	ND	3.7	3.9
Fluorene	0.20	18	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorophene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloropropene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Isosafrole	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
Methapyrilene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
4,4-Methylenebis(2-chloroanilne)	4.0	<20	<200	<200	<20	ND	ND	ND	ND	ND	ND	ND	ND
Methyl methanesulfonate	0.40	<2.0	<20	<20	<2.0	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	0.20	60	<10	<10	35	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	0.20	25	<10	<10	13	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Naphthoquinone	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
1-Naphthylamine	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
2-Naphthylamine	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
n-Nitrosodi-n-butylamine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND

(Continued)

TABLE 2-8. (Continued)

Parameter	Detection Limit (ug/g)	Solid Waste Feed 8/1 (ug/g)	Solid Waste Feed 8/2 (ug/g)	Solid Waste Feed 8/3-4 (ug/g)	Solid Waste Feed 8/3-4D (ug/g)	Scrubber Solids 8/1 (ug/g)	Scrubber Solids 8/2 (ug/g)	Scrubber Solids 8/3-4 (ug/g)	Scrubber Solids 8/3-4D (ug/g)	Furnace Ash 8/1 (ug/g)	Furnace Ash 8/2 (ug/g)	Furnace Ash 8/3-4 (ug/g)	Furnace Ash 8/3-4D (ug/g)
N-Nitrosodiethylamine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosomethylethylamine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosomorpholine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosopiperidine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosopyrrolidene	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
5-Nitro-o-toluidine	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorobenzene	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Pentachloroethane	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Pentachloronitrobenzene	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
Phenacetin	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	0.20	90	<10	<10	<1.0	ND	ND	ND	ND	ND	3.8	7.4	7.4
Phenol	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	2.9	4.2	2.2	3.8
2-Picoline	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
Pronamide	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	0.20	55	<10	<10	<1.0	ND	ND	ND	ND	ND	2.6	4.1	5.0
Pyridine	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Resorcinol	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
Safrole	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4,5-Tetrachlorobenzene	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4,6-Tetrachlorophenol	2.0	<10	<100	<100	<10	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	0.20	<1.0	<10	<10	13	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	1.0	<5.0	<50	<50	<5.0	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	0.20	<1.0	<10	<10	<1.0	ND	ND	ND	ND	ND	ND	ND	ND

[a] Detection limits increased due to matrix effects.

NA - Standard was not available; the compound was searched using an NBS library of 42,000 compounds.

ND - Not detected.

TABLE 2-9. RESULTS OF SEMI-VOLATILE ORGANICS ANALYSIS ON STACK GAS

		8/1 2121-0130		8/2 1800-2211		8/4 0930-1445		8/4 DUP 0930-1445	
Sample Volume (SCF):		136.65		156.3		143.2		150.1	
Stack Gas Flow (DSCFM):		5370		4570		4140		4690	
Analyte	Detection Limit (ug)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)
Acenaphthalene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Acenaphthene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Acetophenone	2	6600	1700	ND	<0.45	ND	<0.49	6500	1500
2-Acetylaminofluorene	40	ND	<10	ND	<9.0	ND	<9.9	ND	<9.4
4-Aminobiphenyl	40	ND	<10	ND	<9.0	ND	<9.9	ND	<9.4
Aniline	4	ND	<1.0	ND	<0.90	ND	<0.99	ND	<0.94
Anthracene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Aramite	N/A								
Benz(a)anthracene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Benzenethiol	N/A								
Benzidine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
Benzo(a)pyrene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Benzo(b)fluoranthene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Benzo(g,h,i)perylene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Benzoic acid	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
Benzo(k)fluoranthene	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
p-Benzoquinone	N/A								
Benzyl alcohol	4	ND	<1.0	ND	<0.90	ND	<0.99	ND	<0.94
bis(2-Chloroethoxy)ethane	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
bis(2-Chloroethyl)ether	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
bis(2-Chloroisopropyl)ether	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
bis(2-Ethylhexyl)phthalate	2	7500	1900	ND	<0.45	ND	<0.49	ND	<0.47
4-Bromophenyl phenyl ether	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Butyl benzyl phthalate	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
2-sec-butyl-4,6-dinitrophenol	N/A								
p-Chloroaniline	40	ND	<10	ND	<9.0	ND	<9.9	ND	<9.4
Chlorobenzilate	N/A								
2-Chloroethyl vinyl ether	N/A								
p-Chloro-m-cresol	2	ND	<0.52	ND	<0.45	ND	<0.49	2000	470
2-Chloronaphthalene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
2-Chlorophenol	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
4-Chlorophenyl phenyl ether	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Chrysene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47

(Continued)

TABLE 2-9. (Continued)

		8/1 2121-0130		8/2 1800-2211		8/4 0930-1445		8/4 DUP 0930-1445	
Sample Volume (SCF):		136.65		156.3		143.2		150.1	
Stack Gas Flow (DSCFM):		5370		4570		4140		4690	
Analyte	Detection Limit (ug)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)
o-Cresol	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
p-Cresol	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Dibenzo(a,e)pyrene	N/A								
Dibenzofuran	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Dibenzo(a,h)anthracene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Dibenzo(a,h)pyrene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Dibenzo(a,i)pyrene	N/A								
1,2-Dichlorobenzene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
1,3-Dichlorobenzene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
1,4-Dichlorobenzene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
3,3'-Dichlorobenzidine	4	ND	<1.0	ND	<0.90	ND	<0.99	ND	<0.94
2,4-Dichlorophenol	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
2,6-Dichlorophenol	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Diethylphthalate	2	21000	5400	51000	12000	57000	14000	80000	19000
p-Dimethylaminoazobenzene	40	ND	<10	ND	<9.0	ND	<9.9	ND	<9.4
3,3'-Dimethoxybenzidine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
7,12-Dimethylbenz(a)anthracene	4	ND	<1.0	ND	<0.90	ND	<0.99	ND	<0.94
3,3'-Dimethylbenzidine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
2,2-Dimethylphenethylamine	40	ND	<10	ND	<9.0	ND	<9.9	ND	<9.4
2,4-Dimethylphenol	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Dimethylphthalate	2	4000	1000	6300	1400	8100	2000	5800	1400
1,4-Dinitrobenzene	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
4,6-Dinitro-o-cresol	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
2,4-Dinitrophenol	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
2,4-Dinitrotoluene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
2,6-Dinitrotoluene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Di-n-butylphthalate	2	26000	6700	30000	6800	62000	15000	69000	16000
Di-n-octylphthalate	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Di-n-propylnitrosamine	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Diphenylamine	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
1,2-Diphenylhydrazine	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Fluoranthene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Fluorene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47

(Continued)

TABLE 2-9. (Continued)

		8/1		8/2		8/4		8/4 DUP	
		2121-0130		1800-2211		0930-1445		0930-1445	
Sample Volume (SCF):		136.65		156.3		143.2		150.1	
Stack Gas Flow (DSCFM):		5370		4570		4140		4690	
Analyte	Detection Limit (ug)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)
Hexachlorobenzene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Hexachlorocyclopentadiene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Hexachloroethane	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Hexachlorophene	N/A								
Hexachloropropene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Indeno(1,2,3-c,d)pyrene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Isophorone	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Isosafrole	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
Methapyriline	N/A								
3-Methylcholanthrene	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
4,4-Methyl-n-bis(2-chloroaniline)	40	ND	<10	ND	<9.0	ND	<9.9	ND	<9.4
Methyl methanesulfonate	4	ND	<1.0	ND	<0.90	ND	<0.99	ND	<0.94
2-Methylnaphthalene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Naphthalene	2	4300	1100	ND	<0.45	ND	<0.49	6900	1600
1,4-Naphthoquinone	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
1-Naphthylamine	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
2-Naphthylamine	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
2-Nitroaniline	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
3-Nitroaniline	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
4-Nitroaniline	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
Nitrobenzene	2	ND	<0.52	ND	<0.45	ND	<0.495	ND	<0.474
2-Nitrophenol	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
4-Nitrophenol	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
N-Nitrosodi-n-butylamine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
N-Nitrosodiethylamine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
N-Nitrosodimethylamine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
N-Nitrosodiphenylamine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
N-Nitrosomethylethylamine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
N-Nitrosomorpholine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
N-Nitrosopiperidine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
N-Nitrosopyrrolidene	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
5-Nitro-o-toluidine	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4

(Continued)

TABLE 2-9. (Continued)

Sample Volume (SCF): Stack Gas Flow (DSCFM):		8/1 2121-0130 136.65 5370		8/2 1800-2211 156.3 4570		8/4 0930-1445 143.2 4140		8/4 DUP 0530-1445 150.1 4590	
Analyte	Detection Limit (ug)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)
Pentachlorobenzene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.470
Pentachloroethane	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.470
Pentachloronitrobenzene	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
Pentachlorophenol	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
Phenacetin	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
Phenanthrene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Phenol	2	2400	620	ND	<0.45	ND	<0.49	2300	540
2-Picoline	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
Pronamide	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
Pyrene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Pyridine	2	ND	<0.52	31000	7000	ND	<0.49	ND	<0.47
Resorcinol	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
Safrole	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
1,2,4,5-Tetrachlorobenzene	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
2,3,4,6-Tetrachlorophenol	20	ND	<5.2	ND	<4.5	ND	<4.9	ND	<4.7
1,2,4-Trichlorobenzene	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47
2,4,5-Trichlorophenol	10	ND	<2.6	ND	<2.3	ND	<2.5	ND	<2.4
2,4,6-Trichlorophenol	2	ND	<0.52	ND	<0.45	ND	<0.49	ND	<0.47

N/A - Standard not available.

ND - Not detected.

TABLE 2-10. RESULTS OF SEMI-VOLATILE ANALYSIS ON SCRUBBER LIQUID EFFLUENT AND MAKE-UP WATER

Parameter	Detection Limit (ug/L)	Scrubber Effluent				Make-up Water (ug/L)
		8/1 (ug/L)	8/2 (ug/L)	8/3-4 (ug/L)	8/3-4D (ug/L)	
Acenaphthalene	2.0	ND	ND	ND	ND	ND
Acenaphthene	2.0	ND	ND	ND	ND	ND
Acetophenone	2.0	ND	ND	ND	ND	ND
2-Acetylaminofluorene	50	ND	ND	ND	ND	ND
4-Aminobiphenyl	50	ND	ND	ND	ND	ND
Aniline	4.0	ND	ND	ND	ND	ND
Anthracene	2.0	ND	ND	ND	ND	ND
Aramite	NA	NA	NA	NA	NA	NA
Benz(a)anthracene	2.0	ND	ND	ND	ND	ND
Benzenethiol	NA	NA	NA	NA	ND	NA
Benzidine	10	ND	ND	ND	ND	ND
Benzo(a)pyrene	2.0	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	2.0	ND	ND	ND	ND	ND
Benzo(gh,h,i)perylene	2.0	ND	ND	ND	ND	ND
Benzoic acid	20	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	10	ND	ND	ND	ND	ND
p-Benzoquinone	NA	NA	NA	NA	NA	NA
Benzyl alcohol	4.0	ND	ND	ND	ND	ND
bis(2-Chloroethoxy)ethane	2.0	ND	ND	ND	ND	ND
bis(2-Chloroethyl)ether	2.0	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl)ether	2.0	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	2.0	223	ND	ND	2.5	ND
4-Bromophenyl phenyl ether	2.0	ND	ND	ND	ND	ND
Butyl benzyl phthalate	2.0	ND	ND	ND	ND	ND
2-Sec-butyl-4,6-dinitrophenol	NA	NA	NA	NA	NA	NA
p-Chloroaniline	40	ND	ND	ND	ND	ND
Chlorobenzilate	NA	NA	NA	NA	NA	NA
2-Chloroethyl vinyl ether	NA	NA	NA	NA	NA	NA
p-Chloro-m-cresol	2.0	ND	ND	ND	3.2	ND
2-Chloronaphthalene	2.0	ND	ND	ND	ND	ND
2-Chlorophenol	2.0	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	2.0	ND	ND	ND	ND	ND
Chrysene	2.0	ND	ND	ND	ND	ND
o-Cresol	2.0	ND	ND	ND	ND	ND
p-Cresol	2.0	ND	ND	ND	ND	ND
Dibenzo(a,e)pyrene	NA	NA	NA	NA	NA	NA
Dibenzofuran	2.0	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	2.0	ND	ND	ND	ND	ND
Dibenzo(a,h)pyrene	2.0	ND	ND	ND	ND	ND
Dibenzo(a,i)pyrene	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	2.0	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	2.0	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	2.0	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	4.0	ND	ND	ND	ND	ND
2,4-Dichlorophenol	2.0	ND	ND	ND	ND	ND
2,6-Dichlorophenol	2.0	ND	ND	ND	ND	ND

(Continued)

TABLE 2-10. (Continued)

Parameter	Detection Limit (ug/L)	Scrubber Effluent				Make-up Water (ug/L)
		8/1 (ug/L)	8/2 (ug/L)	8/3-4 (ug/L)	8/3-4D (ug/L)	
Diethylphthalate	2.0	ND	7.3	ND	ND	ND
p-Dimethylaminoazobenzene	50	ND	ND	ND	ND	ND
3,3'-Dimethoxybenzidine	10	ND	ND	ND	ND	ND
7,12-Dimethylbenz(a)anthracene	4.0	ND	ND	ND	ND	ND
3,3'-Dimethylbenzidine	10	ND	ND	ND	ND	ND
2,2-Dimethylphenethylamine	50	ND	ND	ND	ND	ND
2,4-Dimethylphenol	2.0	ND	ND	ND	ND	ND
Dimethylphthalate	2.0	ND	ND	ND	ND	ND
1,4-Dinitrobenzene	20	ND	ND	ND	ND	ND
4,6-Dinitro-o-cresol	10	ND	ND	ND	ND	ND
2,4-Dinitrophenol	10	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	2.0	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	2.0	ND	ND	ND	ND	ND
Di-n-butylphthalate	2.0	ND	23	ND	ND	ND
Di-n-octylphthalate	2.0	ND	ND	384	ND	ND
Di-n-propylnitrosamine	2.0	ND	ND	ND	ND	ND
Diphenylamine	2.0	ND	ND	ND	ND	ND
1,2-Diphenylhydrazine	2.0	ND	ND	ND	ND	ND
Fluoranthene	2.0	ND	ND	ND	ND	ND
Fluorene	2.0	ND	ND	ND	ND	ND
Hexachlorobenzene	2.0	ND	ND	ND	ND	ND
Hexachlorobutadiene	2.0	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	2.0	ND	ND	ND	ND	ND
Hexachloroethane	2.0	ND	ND	ND	ND	ND
Hexachlorophene	NA	NA	NA	NA	NA	NA
Hexachloropropene	2.0	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	2.0	ND	ND	ND	ND	ND
Isophorone	2.0	ND	ND	ND	ND	ND
Isosafrole	20	ND	ND	ND	ND	ND
Methapyrilene	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	20	ND	ND	ND	ND	ND
4,4-Methylenebis(2-chloroanilne)	40	ND	ND	ND	ND	ND
Methyl methanesulfonate	4.0	ND	ND	ND	ND	ND
2-Methylnaphthalene	2.0	ND	ND	ND	ND	ND
Naphthalene	2.0	ND	ND	ND	ND	ND
1,4-Naphthoquinone	20	ND	ND	ND	ND	ND
1-Naphthylamine	20	ND	ND	ND	ND	ND
2-Naphthylamine	20	ND	ND	ND	ND	ND
2-Nitroaniline	10	ND	ND	ND	ND	ND
3-Nitroaniline	10	ND	ND	ND	ND	ND
4-Nitroaniline	10	ND	ND	ND	ND	ND
Nitrobenzene	2.0	ND	ND	ND	ND	ND

(Continued)

TABLE 2-10. (Continued)

Parameter	Detection Limit (ug/L)	Scrubber Effluent 8/1 (ug/L)	8/2 (ug/L)	8/3-4 (ug/L)	8/3-4D (ug/L)	Make-up Water (ug/L)
2-Nitrophenol	10	ND	ND	ND	ND	ND
4-Nitrophenol	10	ND	ND	ND	ND	ND
n-Nitrosodi-n-butylamine	10	ND	ND	ND	ND	ND
N-Nitrosodiethylamine	10	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	10	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	10	ND	ND	ND	ND	ND
N-Nitrosomethylethylamine	10	ND	ND	ND	ND	ND
N-Nitrosomorpholine	10	ND	ND	ND	ND	ND
N-Nitrosopiperidine	10	ND	ND	ND	ND	ND
N-Nitrosopyrrolidene	10	ND	ND	ND	ND	ND
5-Nitro-o-toluidine	10	ND	ND	ND	ND	ND
Pentachlorobenzene	2.0	ND	ND	ND	ND	ND
Pentachloroethane	2.0	ND	ND	ND	ND	ND
Pentachloronitrobenzene	20	ND	ND	ND	ND	ND
Pentachlorophenol	10	ND	ND	ND	ND	ND
Phenacetin	20	ND	ND	ND	ND	ND
Phenanthrene	2.0	ND	ND	ND	ND	ND
Phenol	2.0	ND	ND	ND	ND	ND
2-Picoline	20	ND	ND	ND	ND	ND
Pronamide	20	ND	ND	ND	ND	ND
Pyrene	2.0	ND	ND	ND	ND	ND
Pyridine	2.0	ND	ND	ND	ND	ND
Resorcinol	2.0	ND	ND	ND	ND	ND
Safrole	20	ND	ND	ND	ND	ND
1,2,4,5-Tetrachlorobenzene	20	ND	ND	ND	ND	ND
2,3,4,6-Tetrachlorophenol	20	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	2.0	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	10	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	2.0	ND	ND	ND	ND	ND

NA - Standard was not available; the compound was searched using an NBS library of 42,000 compounds.

2.4 Volatile Organics

Volatile organics were analyzed in the solid waste feed, scrubber solids, kiln ash, scrubber effluent water, and scrubber make-up water using Method 8240 of SW-846, 3rd edition. Analysis was performed for the volatile organics of the Appendix IX list. The data tables list the target analytes.

Table 2-11 presents the volatile organics analytical results for solid waste feed, scrubber solids, and kiln ash. Volatile organics results for the scrubber waters are provided in Table 2-12.

Volatile organics in the stack gas were measured using the VOST (Volatile Organics Sampling Train). The sampling method is Method 0030 of SW-846, 3rd edition, and Method 5040 is the analytical protocol. The target analytes and results of the VOST measurements are shown in Table 2-13.

2.5 Metals

Thirty metals were analyzed in the solid waste feed, scrubber solids, kiln ash, scrubber effluent water, and scrubber make-up water. Analysis was performed using ICPES (inductively coupled plasma emission spectroscopy) and AAS (atomic absorption spectroscopy). SW-846, 3rd edition protocols were used for the respective analyses.

Metals results for the solid waste feed, scrubber solids, and kiln ash are given in Table 2-14, and scrubber effluent water and scrubber make-up water results are in Table 2-15.

Particulate matter collected from the stack gas on the EPA Method 5 filter was also analyzed for the thirty elements. The results of those analyses are provided in Table 2-16.

TABLE 2-11. VOLATILE ORGANICS RESULTS FOR SOLIDS STREAMS

Compound	Detection Limit [ng/g]	Solid Waste Feed				Scrubber Solids				Furnace Ash			
		8/1[a] [ng/g]	8/2[a] [ng/g]	8/3-4[a] [ng/g]	8/3-40[a] [ng/g]	8/1 [ng/g]	8/2 [ng/g]	8/3-4 [ng/g]	8/3-40 [ng/g]	8/1 [ng/g]	8/2 [ng/g]	8/3-4 [ng/g]	8/3-40 [ng/g]
Acetone	50	ND	ND	220	84	ND	86	83	ND	98	110	500	67
Acetonitrile	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acrolein	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acrylonitrile	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	2.0	6.8	36	16	15	ND	ND	ND	ND	22	5.9	8.8	4.7
Bromoform	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	2.0	4.8	ND	ND	3.1	ND	ND	ND	ND	19	18	37	31
Carbon Tetrachloride	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloro-1,3-butadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorodibromomethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	2.0	ND	8.9	4.2	3.7	8.7	4.0	5.8	ND	ND	7.1	5.0	ND
Chloromethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Chloropropene	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dibromo-3-chloropropane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dibromoethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromomethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorobromomethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	18	88	ND	ND
1,1-Dichloroethene	2.0	ND	11	ND	7.7	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylbenzene	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl Benzene	2.0	39	140	77	82	ND	ND	ND	ND	ND	ND	ND	ND
Ethylene Oxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl Methacrylate	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iodomethane	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	50	88	79	120	98	65	ND	ND	ND	520	240	180	220
Methyl Ethyl Ketone	40	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methyl Methacrylate	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propenenitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	2	4.9	ND	ND	ND	8.0	ND	ND	ND	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethylene	2.0	ND	32	34	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	2.0	130	440	250	300	ND	ND	ND	ND	39	8.8	7.3	8.2
Trans-1,4-dichloro-2-butene	25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloroethene	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trans-1,3-dichloropropene	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	2.0	44	66	58	78	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	2.0	16	46	22	26	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	2.0	ND	3.8	12	19	ND	ND	ND	ND	17	3.0	54	8.9
Trichloromethanethiol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Acetate	25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	2.0	260	764	400	480	20	ND	ND	ND	ND	ND	ND	ND

[a] Matrix spike outside of acceptable QA/QC limits indicating matrix effects.

TABLE 2-12. VOLATILE ORGANICS RESULTS FOR SCRUBBER EFFLUENT AND MAKE-UP WATER

Parameter	Detection Limit (ug/L)	Scrubber Effluent 8/1 (ug/L)	8/2 (ug/L)	8/3-4 (ug/L)	8/3-4D (ug/L)	Make-up Water (ug/L)
Acetone	50	ND	ND	ND	ND	ND
Acetonitrile	50	ND	ND	ND	ND	ND
Acrolein	10	ND	ND	ND	ND	ND
Acrylonitrile	10	ND	ND	ND	ND	ND
Benzene	2.0	ND	ND	ND	ND	ND
Bromoform	2.0	ND	ND	ND	ND	ND
Bromomethane	2.0	ND	ND	ND	ND	ND
Carbon Disulfide	2.0	ND	ND	ND	ND	ND
Carbon Tetrachloride	2.0	ND	ND	ND	ND	ND
Chlorobenzene	2.0	ND	ND	ND	ND	ND
2-Chloro-1,3-butadiene	NA	NA	NA	NA	NA	NA
Chlorodibromomethane	2.0	ND	ND	ND	ND	ND
Chloroethane	2.0	ND	ND	ND	ND	ND
Chloroform	2.0	ND	ND	ND	ND	ND
Chloromethane	2.0	ND	ND	ND	ND	ND
3-Chloropropene	2.0	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	2.0	ND	ND	ND	ND	ND
1,2-Dibromo-3-chloropropane	2.0	ND	ND	ND	ND	ND
1,2-Dibromoethane	2.0	ND	ND	ND	ND	ND
Dibromomethane	2.0	ND	ND	ND	ND	ND
Dichlorobromomethane	2.0	ND	ND	ND	ND	ND
Dichlorodifluoromethane	2.0	ND	ND	ND	ND	ND
1,1-Dichloroethane	2.0	ND	ND	ND	ND	ND
1,2-Dichloroethane	2.0	ND	ND	ND	ND	ND
1,1-Dichloroethene	2.0	ND	ND	ND	ND	ND
1,2-Dichloropropane	2.0	ND	ND	ND	ND	ND
Dimethylbenzene	2.0	ND	ND	ND	ND	ND
Ethyl Benzene	2.0	ND	ND	ND	ND	ND
Ethylene Oxide	NA	NA	NA	NA	NA	NA
Ethyl Methacrylate	10	ND	ND	ND	ND	ND
2-Hexanone	10	ND	ND	ND	ND	ND
Iodomethane	10	ND	ND	ND	ND	ND
Methylene Chloride	50	ND	ND	ND	ND	ND
Methyl Ethyl Ketone	0.1	ND	ND	ND	ND	ND
Methyl Methacrylate	10	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	10	ND	ND	ND	ND	ND
Propanenitrile	NA	NA	NA	NA	NA	NA
Styrene	2	ND	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	2.0	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	2.0	ND	ND	ND	ND	ND
Tetrachloroethylene	2.0	ND	ND	ND	ND	ND
Toluene	2.0	ND	ND	ND	ND	ND
Trans-1,4-dichloro-2-butene	2.5	ND	ND	ND	ND	ND
trans-1,2-Dichloroethane	2.0	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	2.0	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	2.0	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	2.0	ND	ND	ND	ND	ND
Trichloroethene	2.0	ND	ND	ND	ND	ND
Trichlorofluoromethane	2.0	ND	ND	ND	ND	ND
Trichloromethanethiol	NA	NA	NA	NA	NA	NA
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA
Vinyl Acetate	25	ND	ND	ND	ND	ND
Vinyl Chloride	2.0	ND	ND	ND	ND	ND
Xylenes	2.0	ND	ND	ND	ND	ND

TABLE 2-13. RESULTS OF VOST ANALYSIS ON STACK GAS

Analyte	Detection Limit (ng)	8/1 1810-1830 Sample Volume (L): 20.578		8/1 1917-1937 Sample Volume (L): 20.375		8/2 1410-1430 Sample Volume (L): 20.545		8/2 1705-1725 Sample Volume (L): 20.978	
		Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)
Chloromethane	3	ND	<150	ND	<150	ND	<150	ND	<140
Bromomethane	2	ND	<97	ND	<98	ND	<97	ND	<95
Vinyl chloride	2	ND	<97	ND	<98	ND	<97	ND	<95
Chloroethane	2	ND	<97	ND	<98	ND	<97	ND	<95
Methylene chloride	0.1	<6.3	<310	<6.3	<310	394	19200	254	12100
Trichlorofluoromethane	0.4	ND	<19	ND	<20	ND	<19	ND	<19
1,1-Dichloroethene	0.4	ND	<19	ND	<20	ND	<19	ND	<19
1,1-Dichloroethane	0.7	ND	<34	ND	<34	ND	<34	ND	<33
trans-1,2-Dichloroethene	2	ND	<97	ND	<98	ND	<97	ND	<95
Chloroform	0.5	ND	<24	ND	<25	ND	<24	2000	95000
1,2-Dichloroethane	0.5	ND	<24	ND	<25	ND	<24	ND	<24
1,1,1-Trichloroethane	1	ND	<49	4	200	ND	<49	12	570
Carbon tetrachloride	0.9	ND	<44	ND	<44	ND	<44	ND	<43
Bromodichloromethane	0.8	ND	<39	ND	<39	ND	<39	650	31000
1,2-Dichloropropane	2	ND	<97	ND	<98	ND	<97	ND	<95
cis-1,3-Dichloropropene	2	ND	<97	ND	<98	ND	<97	ND	<95
Trichloroethene	1	ND	<49	ND	<49	ND	<49	ND	<48
Dibromochloromethane	1	ND	<49	ND	<49	ND	<49	ND	<48
1,1,2-Trichloroethane	1	ND	<49	ND	<49	ND	<49	ND	<48
Benzene	0.3	ND	<15	ND	<15	48	2300	200	9500
trans-1,3-Dichloropropene	2	ND	<97	ND	<98	ND	<97	ND	<95
Bromoform	2	ND	<97	ND	<98	ND	<97	ND	<95
Toluene	0.6	ND	<29	ND	<29	150	7300	15	720
Tetrachloroethene	0.9	ND	<44	ND	<44	ND	<44	ND	<43
1,1,2,2-Tetrachloroethane	0.6	ND	<29	ND	<29	ND	<29	ND	<29
Chlorobenzene	0.5	ND	<24	ND	<25	ND	<24	ND	<24
o-Dichlorobenzene		ND		ND		ND		ND	
m-Dichlorobenzene		ND		ND		ND		ND	
p-Dichlorobenzene		ND		ND		ND		ND	
Ethylbenzene	1	ND	<49	ND	<49	ND	<49	44	2100

(Continued)

TABLE 2-13. (Continued)

		8/4 2103-2123 Sample Volume (L): 21.767		8/4 2136-2156 Sample Volume (L): 19.385		8/4 DUP 2010-2030 Sample Volume (L): 21.702		8/4 DUP 2048-2108 Sample Volume (L): 22.255	
Analyte	Detection Limit (ng)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)	Mass Detected (ng)	Stack Gas Conc. (ng/m^3)
Chloromethane	3	ND	<140	210	11000	ND	<140	ND	<140
Bromomethane	2	ND	<92	8	410	ND	<92	ND	<90
Vinyl chloride	2	ND	<92	ND	<100	ND	<92	ND	<90
Chloroethane	2	ND	<92	ND	<100	ND	<92	ND	<90
Methylene chloride	0.1	90	4100	1290	67000	17.7	820	0.7	31
Trichlorofluoromethane	0.4	2	92	1200	62000	7	320	ND	<18
1,1-Dichloroethene	0.4	ND	<18	ND	<21	ND	<18	ND	<18
1,1-Dichloroethane	0.7	ND	<32	ND	<36	ND	<32	ND	<31
trans-1,2-Dichloroethene	2	ND	<92	ND	<100	ND	<92	ND	<90
Chloroform	0.5	2200	100000	1500	77000	350	16000	3	140
1,2-Dichloroethane	0.5	ND	<23	23	1200	ND	<23	ND	<22
1,1,1-Trichloroethane	1	ND	<46	150	7700	ND	<46	4	180
Carbon tetrachloride	0.9	5	230	82	4200	ND	<41	ND	<40
Bromodichloromethane	0.8	680	31000	690	36000	82	3800	ND	<36
1,2-Dichloropropane	2	ND	<92	ND	<100	ND	<92	ND	<90
cis-1,3-Dichloropropene	2	ND	<92	ND	<100	ND	<92	ND	<90
Trichloroethene	1	ND	<46	3	160	ND	<46	ND	<45
Dibromochloromethane	1	170	7800	110	5700	ND	<46	ND	<45
1,1,2-Trichloroethane	1	ND	<46	ND	<52	ND	<46	ND	<45
Benzene	0.3	69	3200	70	3600	14	650	ND	<13
trans-1,3-Dichloropropene	2	ND	<92	ND	<100	ND	<92	ND	<90
Bromoform	2	ND	<92	ND	<100	ND	<92	ND	<90
Toluene	0.6	110	5100	83	4300	6	280	ND	<27
Tetrachloroethene	0.9	ND	<41	14	720	ND	<41	ND	<40
1,1,2,2-Tetrachloroethane	0.6	ND	<28	ND	<31	ND	<28	ND	<27
Chlorobenzene	0.5	ND	<23	ND	<26	ND	<23	ND	<22
o-Dichlorobenzene		ND		ND		ND		ND	
m-Dichlorobenzene		ND		ND		ND		ND	
p-Dichlorobenzene		ND		ND		ND		ND	
Ethylbenzene	1	88	4000	37	1900	ND	<46	ND	<45

(Continued)

TABLE 2-13. (Continued)

Analyte	Detection Limit (ng)	8/4 DUP 2138-2158 Sample Volume (L): 20.704 Mass Detected (ng)	8/4 DUP 2138-2158 Sample Volume (L): 20.704 Stack Gas Conc. (ng/m^3)
Chloromethane	3	25	1200
Bromomethane	2	ND	<97
Vinyl chloride	2	ND	<97
Chloroethane	2	ND	<97
Methylene chloride	0.1	244	11800
Trichlorofluoromethane	0.4	14	680
1,1-Dichloroethene	0.4	ND	<19
1,1-Dichloroethane	0.7	ND	<34
trans-1,2-Dichloroethene	2	ND	<97
Chloroform	0.5	110	5300
1,2-Dichloroethane	0.5	ND	<24
1,1,1-Trichloroethane	1	21	1000
Carbon tetrachloride	0.9	13	630
Bromodichloromethane	0.8	ND	<39
1,2-Dichloropropane	2	ND	<97
cis-1,3-Dichloropropene	2	ND	<97
Trichloroethene	1	ND	<48
Dibromochloromethane	1	ND	<48
1,1,2-Trichloroethane	1	ND	<48
Benzene	0.3	ND	<14
trans-1,3-Dichloropropene	2	ND	<97
Bromoform	2	ND	<97
Toluene	0.6	34	1600
Tetrachloroethene	0.9	ND	<43
1,1,2,2-Tetrachloroethane	0.6	ND	<29
Chlorobenzene	0.5	ND	<24
o-Dichlorobenzene		ND	
m-Dichlorobenzene		ND	
p-Dichlorobenzene		ND	
Ethylbenzene	1	ND	<48

ND - Not detected.

TABLE 2-14. RESULTS OF METALS ANALYSIS OF SOLIDS STREAMS

Parameter	Detection Limit (ug/g)	Solid Waste Feed 8/1 (ug/g)	Solid Waste Feed 8/2 (ug/g)	Solid Waste Feed 8/3-4 (ug/g)	Solid Waste Feed 8/3-4D (ug/g)	Scrubber Solids 8/1 (ug/g)	Scrubber Solids 8/2 (ug/g)	Scrubber Solids 8/3-4 (ug/g)	Scrubber Solids 8/3-4D (ug/g)	Ash 8/1 (ug/g)	Ash 8/2 (ug/g)	Ash 8/3-4 (ug/g)	Ash 8/3-4D (ug/g)
Aluminum	20	1700	1700	1600	1500	18000	17000	16000	16000	3200	2200	2400	2200
Antimony	0.3	2.2[b]	2.1	2.2	3.6[a]	19	20	10	19	2.3	2.7	2.8	5.2
Arsenic	0.4	2.9	2.9[a]	2.0	2.4	75	78	55	58	4.2	2.8	3.3	3.4
Barium	0.9	540	530	480	470	380	350	380	510	930	650	750	700
Beryllium	0.1	0.16[a]	0.11[a]	0.2[a]	0.1[a]	1.1	1.0	1.0	1.1	0.3[a]	0.2[a]	0.3[a]	0.2[a]
Boron	60	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.3	4.6	4.0	3.9	4.1	140	130	130	140	4.0	3.5	4.4	4.0
Calcium	6	39000	38000	39000	34000	160000	160000	170000	170000	52000	58000	45000	46000
Chromium	0.9	24	23	22	20	310	290	300	300	31	24	27	25
Cobalt	1.0	ND	ND	1[a]	2[a]	13	12	12	13	2[a]	2[a]	2[a]	2[a]
Copper	1.0	55	50	46	44	360	360	340	340	77	56	64	59
Iron	3	2100	2200	2000	1900	14000	13000	13000	13000	3100	2400	2500	2500
Lead	0.1	5900[b]	4900	5000	4400	89000	90000	90000	130000	7100	6000	6400	6200
Lithium	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium	10	890	840	880	780	4000	3800	3800	3900	1200	1000	1000	980
Manganese	0.3	52	48	44	45	290	280	270	270	65	51	54	50
Mercury	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Molybdenum	5	ND	ND	ND	ND	10[a]	12[a]	11[a]	10[a]	ND	ND	ND	ND
Nickel	2	8[a]	7[a]	10[a]	7[a]	79	76	79	81	12	8[a]	11	10[a]
Phosphorus	30	690	680	610	590	5000	4600	4100	4000	960	680	740	700
Selenium	0.3	ND[b]	<1[c,b]	ND	ND	<0.6[c]	<0.6	<0.6[c]	<0.6[c]	ND	ND	ND	ND
Silicon	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	0.9	2.1[a]	1.5[a]	2.3[a]	2.0[a]	9.1	7.5	8.0	8.1	3.6[a]	4[a]	5.1	3.4[a]
Sodium	8	2300	8500	5900	5500	5700	9600	10000	14000	2400	8000	5400	6500
Strontium	0.3	62	57	57	50	350	340	330	350	93	72	70	68
Sulfur	500	22000	21000	21000	18000	92000	90000[a,c]	58000	53000	29000	21000	24000	22000
Thallium	9	ND	ND	ND	ND	75	72	69	75	ND	ND	ND	ND
Titanium	5	41	39	44	36	1500	1500	1400	1500	140	110	110	100
Vanadium	2	9[a]	7[a]	11	10	42	37	36	34	14	12	13	12
Zinc	2.4	1100	1100	960	950	16000	16000	16000	16000	1300	880	1100	960

[a] Value is less than 5 times the detection limit.

[b] Spike recovery not within acceptble limits.

[c] Detection limit raised due to matrix effects.

ND Not Detected.

NA Not Analyzed.

TABLE 2-15. METALS ANALYSIS OF SCRUBBER EFFLUENT AND MAKE-UP WATER

Parameter	Detection Limit (ug/g)	Scrubber Effluent 8/1 (ug/g)	8/2 (ug/g)	8/3-4 (ug/g)	8/3-4 D (ug/g)	Make-up Water (ug/g)
Aluminum	0.2	1.1	0.7^{a}	0.6^{a}	0.5^{a}	ND
Antimony	0.003	0.036	0.044	0.014^{d}	0.015^{a}	ND
Arsenic	0.002	0.10^{b}	0.058	0.038^{b}	0.042	ND
Barium	0.009	0.12	0.28	0.077	0.11	ND
Beryllium	0.001	ND	ND	ND	ND	ND
Boron	0.6	ND	ND	ND	ND	ND
Cadmium	0.003	0.004^{a}	0.005^{a}	0.019	0.022	ND
Calcium	0.06	56	11	120	120	3.3
Chromium^{c}	0.009	ND	0.062	ND	ND	ND
Cobalt	0.01	ND	ND	ND	ND	ND
Copper	0.01	0.04^{a}	0.05	0.04^{a}	0.5	ND
Iron	0.03	ND	0.6	ND	ND	ND
Lead	0.003	0.10	11	0.42^{b}	0.36	0.005^{a}
Lithium	0.02	ND	0.03^{a}	ND	ND	ND
Magnesium	0.10	2.5	1.3	3.9	4.0	ND
Manganese	0.003	0.036	0.004^{a}	0.029	0.029	ND
Mercury	0.0002	ND	ND	ND	ND	ND
Molybdenum	0.05	ND	ND	ND	ND	ND
Nickel	0.02	0.03^{a}	ND	0.05^{a}	0.05^{a}	ND
Phosphorus	0.3	0.9^{a}	1.6	0.8^{a}	ND	ND
Selenium	0.003	<0.015^{d}	<0.2^{d}	<0.015^{b,d}	<0.015^{d}	ND
Silicon	0.3	20	9.7	13	13	2.8
Silver	0.009	ND	ND	0.015^{a}	ND	ND
Sodium	0.08	1400^{d}	5100^{d}	1200^{d}	1200^{d}	80
Strontium	0.003	0.086	0.031	0.28	0.28	0.006^{a}
Sulfur	5	1100^{d}	710	700^{d}	680	22^{a}
Thallium	0.09	ND	ND	ND	ND	ND
Titanium	0.05	ND	ND	ND	ND	ND
Vanadium	0.02	0.03^{a}	0.02^{a}	ND	0.02^{a}	ND
Zinc	0.006	1.9	0.14	0.7	0.7	ND

[a] Less than five times the detection limit.
[b] Spike recovery not within acceptable limits.
[c] Total chromium.
[d] Detection limit raised due to matrix effects.

TABLE 2-16. RESULTS OF METALS ANALYSIS ON STACK GAS PARTICULATE

	8/1 0830-1023					8/2 2000-2211				
	Sample Volume (DSCF): 41.444 PM on Filter (grams): 0.3792 Part. Loading (g/DSCF 0.0093 Flow (DSCFM): 6040					Sample Volume (DSCF): 36.932 PM on Filter (grams): 0.2006 Part. Loading (g/DSCF): 0.0056 Flow (DSCFM): 5590				
Analyte	Mass of Analyte (ug)	Filter Blank (ug)	Stack Gas Conc. (ug/dscf)	Conc. in PM (ug/g)	MER (g/hr)	Mass of Analyte (ug)	Filter Blank (ug)	Stack Gas Conc. (ug/dscf)	Conc. in PM (ug/g)	MER (g/hr)
Aluminum	<40	0	<0.97	<110	<0.36	<40	0	<1.1	<200	<0.38
Antimony	14	0	0.34	37	0.12	14	0	0.38	70	0.13
Arsenic	7.2	0	0.17	19	0.064	7.2	0	0.19	36	0.067
Barium	130	0	3.1	340	1.2	130	0	3.5	650	1.2
Beryllium	<0.2	0	<0.00	<0.53	<0.002	<0.2	0	<0.01	<1.00	<0.002
Boron	<120	0	<2.90	<320	<1.1	<120	0	<3.3	<600	<1.1
Cadmium	370	0.9	8.9	970	3.3	370	0.9	10	1800	3.5
Calcium	370	50	7.7	840	2.8	370	50	8.7	1600	3.0
Chromium	61	2	1.4	156	0.52	61	2	1.6	290	0.55
Cobalt	<2	0	<0.05	<5.3	<0.018	<2	0	<0.05	<10	<0.019
Copper	80	0	1.9	210	0.71	80	0	2.2	400	0.75
Iron	84	0	2.0	220	0.74	84	0	2.3	420	0.79
Lead	230000	850	5500	600000	2000	110000	850	3000	540000	1000
Lithium	<4	0	<0.10	<11	<0.036	<4	0	<0.11	<20	<0.037
Magnesium	34	0	0.82	90	0.30	34	0	0.92	170	0.32
Manganese	2.4	0	0.06	6.3	0.021	2.4	0	0.06	12	0.022
Mercury	<0.02	0	<0.00	<0.05	<0.000	<0.02	0	<0.00	<0.10	<0.000
Molybdenum	10	0	0.24	26	0.089	10	0	0.27	50	0.094
Nickel	8	0	0.19	21	0.071	8	0	0.22	40	0.075
Phosphorus	151	160	LB	LB	LB	151	160	LB	LB	LB
Selenium	<0.6	0	<0.01	<1.6	<0.005	<0.6	0	<0.02	<3.0	<0.006
Silicon	220	70	3.6	400	1.3	220	70	4.1	750	1.4
Silver	3	0	0.07	7.9	0.027	3	0	0.08	15	0.028
Sodium	3900	300	87	9500	32	3900	300	97	18000	34
Strontium	1.9	0	0.05	5.0	0.017	1.9	0	0.05	9.5	0.018
Sulfur	31000	0	750	82000	276	31000	0	840	150000	290
Thallium	120	0	2.9	320	1.07	120	0	3.3	600	1.1
Titanium	<10	0	<0.24	<26	<0.089	<10	0	<0.27	<50	<0.094
Vanadium	<4	0	<0.10	<11	<0.036	<4	0	<0.11	<20	<0.037
Zinc	1800	5	43	4700	16	1800	5	49	8900	17

(Continued)

TABLE 2-16. (Continued)

	8/4 1550-1744					8/4(DUP) 1552-1746				
	Sample Volume (DSCF) 35.536 PM on Filter (grams) 0.1558 Part. Loading (g/DSC 0.0045 Flow (DSCFM): 5000					Sample Volume (DSCF) 33.822 PM on Filter (grams) 0.1474 Part. Loading (g/DSC 0.0045 Flow (DSCFM): 4930				
Analyte	Mass of Analyte (ug)	Filter Blank (ug)	Stack Gas Conc. (ug/dscf)	Conc. in PM (ug/g)	MER (g/hr)	Mass of Analyte (ug)	Filter Blank (ug)	Stack Gas Conc. (ug/dscf)	Conc. in PM (ug/g)	MER (g/hr)
Aluminum	<40	0	<1.1	<260	<0.35	<40	0	<0.18	<270	<0.36
Antimony	14	0	0.39	90	0.12	14	0	0.41	95	0.13
Arsenic	7.2	0	0.20	46	0.062	7.2	0	0.21	49	0.065
Barium	130	0	3.7	830	1.1	130	0	3.8	880	1.2
Beryllium	<0.2	0	<0.01	<1.3	<0.002	<0.2	0	<0.01	<1.4	<1.002
Boron	<120	0	<3.4	<770	<1.0	<120	0	<3.6	<810	<1.1
Cadmium	370	0.9	10	2400	3.2	370	0.9	11	2500	3.3
Calcium	370	50	9.0	2100	2.8	370	50	9.5	2200	2.9
Chromium	61	2	1.7	380	0.51	61	2	1.7	400	0.53
Cobalt	<2	0	<0.06	<13	<0.017	<2	0	<0.06	<14	<0.018
Copper	80	0	2.3	510	0.69	80	0	2.4	540	0.72
Iron	84	0	2.4	540	0.73	84	0	2.5	570	0.76
Lead	94000	850	2600	600000	810	87000	850	2500	580000	780
Lithium	<4	0	<0.11	<26	<0.035	<4	0	<0.12	<27	<0.036
Magnesium	34	0	0.96	220	0.30	34	0	1.0	230	0.31
Manganese	2.4	0	0.07	15	0.021	2.4	0	0.07	16	0.022
Mercury	<0.02	0	<0.00	<0.13	<0.000	<0.02	0	<0.00	<0.14	<0.000
Molybdenum	10	0	0.28	64	0.087	10	0	0.30	68	0.090
Nickel	8	0	0.23	52	0.069	8	0	0.24	54	0.072
Phosphorus	151	160	LB	LB	LB	151	160	LB	LB	LB
Selenium	<0.6	0	<0.02	<3.9	<0.005	<0.6	0	<0.02	<4.1	<0.005
Silicon	220	70	4.2	960	1.3	220	70	4.4	1000	1.4
Silver	3	0	0.08	19	0.026	3	0	0.09	20	0.027
Sodium	3900	300	100	23000	31	3900	300	110	24000	33
Strontium	1.9	0	0.05	12	0.016	1.9	0	0.06	13	0.017
Sulfur	31000	0	870	200000	270	31000	0	920	210000	280
Thallium	120	0	3.4	770	1.0	120	0	3.6	810	1.1
Titanium	<10	0	<0.28	<64	<0.087	<10	0	<0.30	<68	<0.090
Vanadium	<4	0	<0.11	<26	<0.035	<4	0	<0.12	<27	<0.036
Zinc	1800	5	51	12000	16	1800	5	53	12000	16

LB - Amount detected is less than the blank.

Hexavalent chromium (Cr^{+6}), i.e. soluble chromium, was measured in the stack gas using a modified Method 5 sampling train. The results of the soluble chromium measurements are in Table 2-17.

2.6 Stack Gas Measurements

The particulate loading of the stack gas was determined using EPA Method 5. The results of those tests are shown in Table 2-18.

The impinger train of the EPA Method 5 runs included two 0.1N NaOH impingers for collection of hydrogen chloride (HCl). The impinger solutions were analyzed for chloride and related to the sample gas volume to determine the HCl concentration in the stack gas. Although not detailed in the project QAPP, the caustic impingers were also analyzed for sulfate to determine the concentration of SO_2 in the stack gas. The HCl and SO_2 stack gas results are provided in Table 2-19.

Throughout the testing period, the stack gas was continuously monitored for non-methane hydrocarbons, carbon dioxide, carbon monoxide, oxygen, and nitrogen oxides using continuous monitors. A summary of those results (range, average concentration, and standard deviation) are shown in Table 2-20.

2.7 Solids Characterization

The solid waste feed, kiln ash, and scrubber solids were analyzed for the proximate and ultimate parameters such as moisture, carbon, hydrogen, oxygen, nitrogen, sulfur, chlorine, ash, and higher heating value using ASTM protocols. The results of the proximate/ultimate analyses are shown in Table 2-21.

As a support analysis, the solid waste feed and kiln ash were analyzed for TCO (total chromatographable organics) and GRAV (gravimetric).

TABLE 2-17. P2 RESULTS OF CHROMIUM (VI) ANALYSIS OF THE STACK GAS

8/1 Sample Volume (DSCF): 58		8/2 Sample Volume (DSCF): 56.3		8/3 Sample Volume (DSCF): 50.4		8/3 DUP Sample Volume (DSCF): 51.4	
Mass Detected (ug)	Stack Gas Conc. (ug/m_3)	Mass Detected (ug)	Stack Gas Conc. (ug/m_3)	Mass Detected (ug)	Stack Gas Conc. (ug/m_3)	Mass Detected (ug)	Stack Gas Conc. (ug/m_3)
<230	<140	<247	<155	<216	<151	<233	<160

TABLE 2-18. PARTICULATE LOADING

Date	Time	Sample Volume (DSCF)	Stack Gas Flowrate (DSCFM)	Particulate Loading (grains/DSCF)	Particulate Emission Rate (kg/hr)	Oxygen Content (%)[a]	Particulate Loading Corrected to 7% O_2 (grains/DSCF)[b]	Isokinetic (%)
8/1	0830-1023	41.444	6,040	0.1432	3.36	8.39	0.1590	90.7
8/2	2000-2211	36.932	5,590	0.0866	1.88	8.09	0.0939	88.2[c]
8/4	1550-1744	35.536	5,000	0.0696	1.35	8.31	0.0768	93.9
8/4 Dup	1552-1746	33.822	4,930	0.0689	1.32	8.32	0.0761	90.7

[a] Measured by continuous monitor.

[b] Calculated using following formula: $P_{corr} = P_{act.} \times \frac{14}{21-y}$ where y equals measured O_2 concentration.

[c] Outside acceptable limit.

TABLE 2-19. STACK GAS HCl AND SO_2

Date	Time	Sample Total Cl^- (mg)	Sample Total SO_2 (mg)	Sample Volume (DSCF)	Stack Gas Flowrate (DSCFM	HCl Concentration (ppmv)	SO_2 Concentration (ppmv)	HCl Emission Rate (g/hr)	SO_2 Emission Rate (g/hr)
8/1	0830-1023	<0.092	3.13	41.444	6040	<0.051	0.99	<0.8	27.4
8/2	2000-2211	0.96	118.	36.932	5590	0.60	41.8	8.6	1070.
8/4	1550-1744	0.34	2.60	35.536	5000	0.22	0.96	2.9	22.0
8/4 Dup	1552-1746	0.30	2.35	33.822	4930	0.20	0.91	2.7	20.6

TABLE 2-20. RESULTS OF CONTINUOUS EMISSION MONITORING OF THE STACK GAS

Date		Non-Methane Hydrocarbons (ppmv)	Carbon Dioxide (percent)	Carbon Monoxide (ppmv)	Oxygen (percent)	Nitrogen Oxides (ppmv)
8/1	Range	0.7-12.5	9.2-10.7	0-1.5	7.6-9.7	54-84
	Average[a]	3.8 (2.7)	10.1 (0.3)	0.8 (0.3)	8.5 (0.4)	71 (6)
8/2	Range	0-17	8.1-10.2	0-0	7.6-10.1	41-67
	Average[a]	3.0 (2.8)	9.3 (0.4)	0 (0)	8.6 (0.5)	55 (5)
8/3	Range	1-11	8.3-9.9	0-1	7.5-9.3	42-66
	Average[a]	3.0 (1.8)	9.2 (0.4)	0.5 (0.5)	8.3 (0.4)	53 (5)
8/4	Range	0-23	7.5-10.2	0-2	7.2-10.3	39-69
	Average[a]	4.7 (3.8)	9.0 (0.4)	0.8 (0.4)	8.6 (0.5)	53 (6)

[a] Standard Deviation appears in parentheses.

TABLE 2-21. RESULTS OF PROXIMATE AND ULTIMATE ANALYSES OF SOLIDS STREAMS

	Solid Waste Feed			
	8/1	8/2	8/3-4	8/3-4D
Weight % Moisture	16.63	16.06	14.24	14.37
Weight % Carbon	7.61	6.94	7.77	6.97
Weight % Hydrogen	2.18	2.16	2.30	2.00
Weight % Oxygen	17.85	19.26	15.59	14.10
Weight % Nitrogen	0.06	0.06	0.05	0.05
Weight % Sulfur	2.53	1.78	1.89	1.67
Weight % Chlorine	<0.10	<0.10	<0.10	<0.10
Ash (wt %)	69.77	69.80	72.40	75.21
HHV (Btu/lb)	2064	1639	1728	2018

	Ash			
	8/1	8/2	8/3-4	8/3-4D
Weight % Moisture	17.91	16.01	16.82	16.11
Weight % Carbon	2.43	2.06	3.53	2.57
Weight % Hydrogen	1.61	6.85	1.70	1.44
Weight % Oxygen	13.31	15.02	13.52	13.88
Weight % Nitrogen	0.02	0.02	0.02	0.02
Weight % Sulfur	2.85	2.33	2.29	2.25
Weight % Chlorine	0.19	<0.10	0.26	0.21
Ash (wt %)	79.59	79.72	78.68	79.63
HHV (Btu/lb)				

	Scrubber Solids[a]			
	8/1	8/2	8/3-4	8/3-4D
Weight % Moisture	55.64	47.43	49.94	46.72
Weight % Carbon	1.03	1.27	2.27	3.23
Weight % Hydrogen	0.40	0.33	<0.5	0.34
Weight % Oxygen	<0.5	<0.5	0.02	<0.5
Weight % Nitrogen	0.03	0.03	7.30	0.03
Weight % Sulfur	10.33	9.76	<0.10	6.41
Weight % Chlorine	<0.10	0.10	92.15	<0.10
Ash (wt %)	102.39	92.24		89.62
HHV (Btu/lb)				

[a] Analyses of Scrubber Solids are on a dry basis.

TCO determines the mass relating to organic compounds having boiling points between 100°C and 300°C.

The GRAV analysis determines the mass relating to organic compounds having boiling points in excess of 300°C. The summation of the two analyses represents the total extractable organic material. Table 2-22 presents the TCO and GRAV results.

2.8 Leachability Characteristics

The solids streams solid waste feed, scrubber solids, and kiln ash were subjected to the TCLP (Toxicity Characteristic Leaching Procedure) and the EP Toxicity leaching tests. The two tests differ in that the EP Toxicity test is open to atmosphere and acetic acid is added to maintain pH at 5. The EP Toxicity is most commonly analyzed for eight metals, but herbicides and pesticides may be analyzed if their presence is a possibility. Analyses of the TCLP leachate includes not only the eight metals but also semi-volatile and volatile organics. The TCLP test is conducted using acetic acid extraction fluid using two extraction methods. Volatiles are extracted in a zero headspace extractor to minimize contact with air. Semivolatiles and metals are extracted with a similar method using a sealed container. The results of the TCLP tests on the three solids streams are shown in Table 2-23. The EP Toxicity results for the solid waste feed, scrubber solids, and kiln ash are in Table 2-24.

If a stream contains less than 0.5 percent solids, i.e., a liquid or slurry stream, the solids are filtered from the sample, and the liquid is analyzed for the TCLP or EP Toxicity analytes. Table 2-25 presents the TCLP results for the scrubber effluent water and scrubber make-up water. Table 2-26 presents the EP Toxicity results for the scrubber effluent water and scrubber make-up water.

TABLE 2-22. RESULTS OF TCO AND GRAVIMETRIC ANALYSES

	Total Chromatographable Organic (ug/g)	Gravimetric (g/g)	Total Extractable Organics (%)
Solid Waste Feed			
8/1	343	0.1266	12.7
8/2	322	0.0887	8.9
8/3-4	212	0.0906	9.1
8/3-4D	222	0.0934	9.3
Furnace Ash			
8/1	41.9	0.0042	0.4
8/2	7.14	0.0109	1.1
8/3-4	29.1	0.0174	1.7
8/3-4D	16.5	0.0167	1.7

TABLE 2-23. RESULTS OF TCLP ANALYSIS ON THE SOLIDS STREAMS

Parameter	Detection Limit (mg/L)	Proposed[a] Standard (mg/L)	Solid Waste Feed 8/1 (mg/L)	8/2 (mg/L)	8/3-4 (mg/L)	8/3-4D (mg/L)	Scrubber Solids 8/1 (mg/L)	8/2 (mg/L)	8/3-4 (mg/L)	8/3-4D (mg/L
Arsenic	0.002	5.0	0.007[b]	0.007[b]	0.007[b]	0.008[b]	0.014	0.022	0.015	0.013
Barium	0.009	100	0.20	0.14	0.16	0.16	0.38	0.27	0.34	0.60
Cadmium	0.003	1.0	0.053	0.021	0.035	0.040	0.29	0.069	0.058	0.22
Chromium	0.009	5.0	0.024[b]	0.014[b]	0.026[b]	0.033[b]	0.062	0.037[b]	0.027[b]	0.046
Lead	0.002	5.0	8.6	2.5	3.0	3.5	0.12	0.26	0.30	0.39
Mercury	0.0002	0.2	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	0.003	1.0	<0.08[c,d,e]	ND	<0.08[e]	<0.015[e]	<0.015[e]	<0.015[e]	<0.015[e]	<0.015[e]
Silver	0.009	5.0	0.032[b]	0.016[b]	0.041[b]	0.047	0.062	0.052	0.030[b]	0.059
Acrylonitrile	0.01	5.0	ND	ND	ND	ND[f]	ND	ND	ND	ND
Benzene	0.002	0.07	ND	ND	ND	ND[f]	ND	ND	ND	ND
Carbon Disulfide	0.002	14.4	ND	ND	ND	ND[f]	ND	ND	ND	ND
Carbon Tetrachloride	0.002	0.07	ND	ND	ND	ND[f]	ND	ND	ND	ND
Chlorobenzene	0.002	1.4	ND	ND	ND	ND[f]	ND	ND	ND	ND
Chloroform	0.002	0.07	ND	ND	ND	ND[f]	ND	ND	ND	ND
1,2-Dichloroethane	0.002	0.40	ND	ND	ND	ND[f]	ND	ND	ND	ND
1,1-Dichloroethene	0.002	0.1	ND	ND	ND	ND[f]	ND	ND	ND	ND
Isobutanol	NA	36	NA	NA	NA	NA[f]	NA	NA	NA	NA
Methylene Chloride	0.05	8.6	ND	ND	ND	ND[f]	ND	ND	ND	ND
Methyl Ethyl Ketone	0.05	7.2	ND	ND	ND	ND[f]	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	0.002	10.0	ND	ND	ND	ND[f]	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	0.002	1.3	ND	ND	ND	ND[f]	ND	ND	ND	ND
Tetrachloroethene	0.002	0.1	ND	ND	ND	ND[f]	ND	ND	ND	ND
Toluene	0.002	14.4	0.0062	0.014	0.011	0.0093[f]	ND	ND	ND	ND
1,1,1-Trichloroethane	0.002	30	0.0026	0.0044	0.0025	0.0030[f]	ND	ND	ND	ND
1,1,2-trichloroethane	0.002	1.2	ND	ND	ND	ND[f]	ND	ND	ND	ND
Trichloroethene	0.002	0.07	0.0026	0.0042	0.003	0.0037[f]	0.0041	0.0055	0.0045	0.0044
Vinyl Chloride	0.002	0.05	ND	ND	ND	ND[f]	ND	ND	ND	ND
Bis(2-Chloroethyl)ether	0.005	0.05	ND	ND	ND	ND	ND	ND	ND	ND
m-Cresol	0.005	10.0	ND	0.016	0.012	ND	ND	ND	ND	ND
o-Cresol	0.002	10.0	ND	ND	ND	ND	ND	ND	ND	ND
p-Cresol	0.005	10.0	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	0.005	4.3	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	0.002	10.8	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	0.002	0.13	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	0.002	0.13	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	0.002	0.72	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	0.002	4.3	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	0.002	10.0	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	0.002	3.6	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	0.010	14.4	0.027	ND	0.020	0.027	ND	ND	ND	ND
Pyridine	0.010	5.0	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4,6-Tetrachlorophenol	0.020	1.5	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	0.005	5.8	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	0.005	0.30	ND	ND	ND	ND	ND	ND	ND	ND

[a] Toxicity Characteristics Standard proposed in FR Vol. 51, No. 114, June 13, 1986 for 40 CFR 261.

(Continued)

[b] Value is less than 5 times the detection limit.

[c] Spike recovery not within accetable limits.

[d] Value determined by the method of standard additions.

[e] Detection limit raised due to matrix effects.

[f] Matrix spike was outside of acceptable QA limits.

ND - Not Detected.

NA - Standard Not Available.

TABLE 2-23. (Continued)

Parameter	Detection Limit (mg/L)	Proposed[a] Standard (mg/L)	Ash 8/1 (mg/L)	Ash 8/2 (mg/L)	Ash 8/3-4 (mg/L)	Ash 8/3-4D (mg/L)	Extraction Blanks 8/1 (mg/L)	Extraction Blanks 8/2 (mg/L)	Extraction Blanks 8/3 (mg/L)
Arsenic	0.002	5.0	0.004[b]	0.008[b]	0.008[b]	0.007[b]	0.004[b]	0.003[b]	ND
Barium	0.009	100	0.24	0.21	0.27	0.28	0.015[b]	ND	0.011[b]
Cadmium	0.003	1.0	0.006[b]	0.005[b]	0.007[b]	0.006[b]	ND	ND	ND
Chromium	0.009	5.0	0.037[b]	0.041[b]	0.035[b]	0.033[b]	ND	ND	ND
Lead	0.002	5.0	0.011	0.008	0.017	0.009	0.026	0.040	0.14
Mercury	0.0002	0.2	ND	ND	ND	ND	ND	ND	ND
Selenium	0.003	1.0	<0.08[e]	<0.015[e]	<0.015[e]	<0.015[e]	ND	ND	ND
Silver	0.009	5.0	0.068	0.061	<0.015[e]	0.053	ND	ND	ND
Acrylonitrile	0.01	5.0	ND	ND	0.052	ND			
Benzene	0.002	0.07	ND	0.0027	ND	0.0026			
Carbon Disulfide	0.002	14.4	ND	ND	ND	ND			
Carbon Tetrachloride	0.002	0.07	ND	ND	ND	ND			
Chlorobenzene	0.002	1.4	ND	ND	ND	ND			
Chloroform	0.002	0.07	ND	ND	ND	ND			
1,2-Dichloroethane	0.002	0.40	ND	ND	ND	ND			
1,1-Dichloroethane	0.002	0.1	ND	ND	ND	ND			
Isobutanol	NA	36	NA	NA	NA	NA			
Methylene Chloride	0.05	8.6	0.060	ND	ND	ND			
Methyl Ethyl Ketone	0.05	7.2	ND	ND	ND	ND			
1,1,1,2-Tetrachloroethane	0.002	10.0	ND	ND	ND	ND			
1,1,2,2-Tetrachloroethane	0.002	1.3	ND	ND	ND	ND			
Tetrachloroethane	0.002	0.1	ND	ND	ND	ND			
Toluene	0.002	14.4	0.0062	ND	ND	ND			
1,1,1-Trichloroethane	0.002	30	0.0026	ND	ND	ND			
1,1,2-trichloroethane	0.002	1.2	ND	ND	ND	ND			
Trichloroethane	0.002	0.07	0.0026	ND	ND	ND			
Vinyl Chloride	0.002	0.05	ND	ND	ND	ND			
Bis(2-Chloroethyl)ether	0.005	0.05	ND	ND	ND	ND			
m-Cresol	0.005	10.0	ND	ND	ND	ND			
o-Cresol	0.002	10.0	ND	ND	ND	ND			
p-Cresol	0.005	10.0	ND	ND	ND	ND			
1,2-Dichlorobenzene	0.005	4.3	ND	ND	ND	ND			
1,4-Dichlorobenzene	0.002	10.8	ND	ND	ND	ND			
2,4-Dinitrotoluene	0.002	0.13	ND	ND	ND	ND			
Hexachlorobenzene	0.002	0.13	ND	ND	ND	ND			
Hexachlorobutadiene	0.002	0.72	ND	ND	ND	ND			
Hexachloroethane	0.002	4.3	ND	ND	ND	ND			
Nitrobenzene	0.002	10.0	ND	ND	ND	ND			
Pentachlorophenol	0.002	3.6	ND	ND	ND	ND			
Phenol	0.010	14.4	ND	ND	ND	ND			
Pyridine	0.010	5.0	ND	ND	ND	ND			
2,3,4,6-Tetrachlorophenol	0.020	1.5	ND	ND	ND	ND			
2,4,5-Trichlorophenol	0.005	5.8	ND	ND	ND	ND			
2,4,6-Trichlorophenol	0.005	0.30	ND	ND	ND	ND			

[a] Toxicity Characteristics Standard proposed in FR Vol. 51, No. 114, June 13, 1986 for 40 CFR 261.
[b] Value is less than 5 times the detection limit.
[c] Spike recovery not within accetable limits.
[d] Value determined by the method of standard additions.
[e] Detection limit raised due to matrix effects.
[f] Matrix spike was outside of acceptable QA limits.
ND - Not Detected.
NA - Standard Not Available.

TABLE 2-24. RESULTS OF EP TOXICITY ANALYSIS ON THE SOLID EFFLUENT STREAMS

Parameter	Detection Limit (mg/L)	Standard[a] (mg/L)	Solid Waste Feed 8/1 (mg/L)	8/2 (mg/L)	8/3-4 (mg/L)	8/3-4D (mg/L)	Scrubber Solids 8/1 (mg/L)	8/2 (mg/L)	8/3-4 (mg/L)	8/3-4D (mg/L
Arsenic	0.002	5.0	0.012	0.007[b]	0.012	0.008	ND	0.019	ND	ND
Barium	0.009	100	0.23	0.31	0.39	0.32	0.27	0.56	0.52	0.69
Cadmium	0.003	1.0	0.072	0.079	0.14	0.086	0.88	1.9	1.5	0.49
Chromium	0.009	5.0	0.029[b]	0.031[b]	0.15	0.037[b]	0.056	0.65	0.048	0.040[b]
Lead	0.002	5.0	27	29	57[c]	24	3.3	40	35	3.1
Mercury	0.0002	0.2	0.0004[b]	0.0002[b]	0.0006[b]	0.0003[b]	ND	0.0005[b]	0.0005[b]	0.0002[b]
Selenium	C.003	1.0	ND	ND	ND	<0.012[c,d]	ND	ND	ND	ND
Silver	0.009	5.0	0.014[b]	ND	0.028	0.028	0.020[b]	0.041[b]	0.031[b]	0.037[b]

(Continued)

Parameter	Detection Limit (mg/L)	Standard[a] (mg/L)	Ash 8/1 (mg/L)	8/2 (mg/L)	8/3-4 (mg/L)	8/3-4D (mg/L)	Extraction Blank
Arsenic	0.002	5.0	0.025	0.008[b]	0.022	0.026	ND
Barium	0.009	100	1.6	1.2	1.0	1.6	ND
Cadmium	0.003	1.0	0.13	0.088	0.079	0.099	ND
Chromium	0.009	5.0	0.099	0.059	0.029[b]	0.039[b]	ND
Lead	0.002	5.0	25	28	36	36	0.010
Mercury	0.0002	0.2	0.005	0.0008[b]	ND	0.0002[b]	ND
Selenium	0.003	1.0	ND	ND	ND	ND	ND
Silver	0.009	5.0	0.036[b]	0.044[b]	0.032[b]	0.013[b]	ND

[a] EP Toxicity Characteristic Standard, 40 CFR 216.24.

[b] Value is less than 5 times the detection limit.

[c] Spike recovery not within accetable limits.

[d] Detection limit raised due to matrix effects.

ND - Not Detected.

TABLE 2-25. RESULTS OF TCLP ANALYSIS OF SCRUBBER LIQUID EFFLUENT AND MAKE-UP WATER

Parameter	Detection Limit (mg/L)	Proposed[a] Standard (mg/L)	Scrubber Liquid Effluent 8/1 (mg/L)	8/2 (mg/L)	8/3-4 (mg/L)	8/3-4D (mg/L)	Make-up Water (mg/L)
Arsenic	0.002	5.0	0.10[b]	0.058	0.038[b]	0.042	ND
Barium	0.009	100	0.12	0.28	0.077	0.11	ND
Cadmium	0.003	1.0	0.004[c]	0.005[c]	0.019	0.022	ND
Chromium	0.009	5.0	ND	0.062	ND	ND	ND
Lead	0.003	5.0	0.10	11	0.42[b]	0.36	0.005[c]
Mercury	0.0002	0.2	ND	ND	ND	ND	ND
Selenium	0.003	1.0	<0.015[d]	<0.2[d]	<0.015[d]	<0.015[d]	ND
Silver	0.009	5.0	ND	ND	0.015[c]	ND	ND
Acrylonitrile	0.01	5.0	ND	ND	ND	ND	ND
Benzene	0.002	0.07	ND	ND	ND	ND	ND
Carbon Disulfide	0.002	14.4	ND	ND	ND	ND	ND
Carbon Tetrachloride	0.002	0.07	ND	ND	ND	ND	ND
Chlorobenzene	0.002	1.4	ND	ND	ND	ND	ND
Chloroform	0.002	0.07	ND	ND	ND	ND	ND
1,2-Dichloroethane	0.002	0.4	ND	ND	ND	ND	0.006
1,1-Dichloroethene	0.002	0.1	ND	ND	ND	ND	ND
Isobutanol	NA	36	NA	NA	NA	NA	NA
Methylene Chloride	0.05	8.6	ND	ND	ND	ND	ND
Methyl Ethyl Ketone	0.05	7.2	ND	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	0.002	10.0	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	0.002	1.3	ND	ND	ND	ND	ND
Tetrachloroethylene	0.002	0.1	ND	ND	ND	ND	ND
Toluene	0.002	14.4	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	0.002	30	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	0.002	1.2	ND	ND	ND	ND	ND
Trichloroethene	0.002	0.07	ND	ND	ND	ND	ND
Vinyl Chloride	0.002	0.05	ND	ND	ND	ND	ND
Bis(2-Chloroethyl)ether	0.005	0.05	ND	ND	ND	ND	ND
m-Cresol	0.005	10.0	ND	ND	ND	ND	ND
o-Cresol	0.002	10.0	ND	ND	ND	ND	ND
p-Cresol	0.005	10.0	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	0.005	4.3	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	0.002	10.8	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	0.002	0.13	ND	ND	ND	ND	ND
Hexachlorobenzene	0.002	0.13	ND	ND	ND	ND	ND
Hexachlorobutadiene	0.002	0.72	ND	ND	ND	ND	ND
Hexachloroethane	0.002	4.3	ND	ND	ND	ND	ND
Nitrobenzene	0.002	10.0	ND	ND	ND	ND	ND
Pentachlorophenol	0.002	3.6	ND	ND	ND	ND	ND
Phenol	0.010	14.4	ND	ND	ND	ND	ND
Pyridine	0.010	5.0	ND	ND	ND	ND	ND
2,3,4,6-Tetrachlorophenol	0.020	1.5	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	0.005	5.8	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	0.005	0.30	ND	ND	ND	ND	ND

[a] Toxicity Characteristic Standard proposed in FR Vol. 51, No. 114, June 13, 1986 for 40 CFR 261.

[b] Spike recovery not within acceptable limits.

[c] Value is less than 5 times the detection limit.

[d] Detection limit raised due to matrix effects.

ND - Not Detected.

NA - Standard was not available; the compound was searched using an NBS library of 42,000 compounds.

TABLE 2-26. RESULTS OF EP TOXICITY ANALYSES OF SCRUBBER LIQUID EFFLUENT AND MAKE-UP WATER

Parameter	Detection Limit (mg/L)	Standard[a] (mg/L)	Scrubber Liquid Effluent				Make-up Water (mg/L)
			8/1 (mg/L)	8/2 (mg/L)	8/3-4 (mg/L)	8/3-4D (mg/L)	
Arsenic	0.002	5.0	0.10[b]	0.058	0.038[b]	0.042	ND
Barium	0.009	100	0.12	0.28	0.077	0.11	ND
Cadmium	0.003	1.0	0.004[c]	0.005[c]	0.019	0.022	ND
Chromium	0.009	5.0	ND	0.062	ND	ND	ND
Lead	0.003	5.0	0.10	11	0.42[b]	0.36	0.005[c]
Mercury	0.0002	0.2	ND	ND	ND	ND	ND
Selenium	0.003	1.0	<0.015[d]	<0.2[d]	<0.015[d]	<0.015[d]	ND
Silver	0.009	5.0	ND	ND	0.015[c]	ND	ND

[a] EP Toxicity Characteristics Standard, 40 CFR 261.24.

[b] Spike recovery not within acceptable limits.

[c] Value is less than 5 times the detection limit.

[d] Detection limit raised due to matrix effects.

ND - Not Detected.

2.9 Wastewater Parameters

The scrubber effluent water and scrubber make-up water were analyzed for TOC (total organic carbon), chloride, TDS (total dissolved solids), TSS (total suspended solids), and pH. The results of those measurements are given Table 2-27.

TABLE 2-27. RESULTS OF ANALYSIS OF WATER QUALITY PARAMETERS

	Scrubber Effluent				Make-up water
	8/1	8/2	8/3-4	8/3-4 D	
TOC (mg/L)	8	9	7	8	3[a]
Cl^- (mg/L)	80	180	500	400	25
TDS (mg/L)	5200	14400	4500	4700	240
TSS (ug/g)	660	450	330	320	
pH	6.85 6.66 6.86 6.71 6.62 6.83 7.25	8.65 8.62 8.75 8.50 8.36 8.04 6.8 5.50 4.4 4.82	7.22 6.32 7.05 8.05 7.15 6.5 5.01 6.0 6.0 5.2 5.63		8.42

[a] Indicates a value less than 5 times the detection limit.

3.0 QUALITY ASSURANCE AND QUALITY CONTROL

The objective of quality assurance and quality control (QA/QC) efforts associated with sampling and analytical activities was to ensure that data collected are of known and sufficient quality to qualitatively and quantitatively characterize the sources of interest. Two primary aspects of the overall QA/QC effort are related to achievement of this objective. First, the QA/QC program forms a framework for controlling data quality within preestablished limits during execution of the sampling and analytical efforts. Second, the QA/QC program forms the basis for estimating uncertainty in the measurement data by providing information necessary for identifying and defining qualitative and quantitative limitations associated with these data. The following sections present a brief description of some of the key elements of the QA/QC effort and an assessment of measurement data quality based on QA/QC results.

Summary and Approach

Overall, QA/QC data associated with the Peak Oil incineration study indicate that the measurement data are acceptable and defensible. Interferences within the sample matrix significantly affected analyte recovery in some cases, which are discussed in the following sections.

The overall QA/QC program for the study was designed to fulfill two related purposes. First, it provided an organized framework for the sampling and analytical efforts. The program was designed to control data quality within preestablished limits and to ensure that it was adequate to achieve the objectives of the program. This involved first establishing data quality objectives for the parameters of interest. Next, protocols were defined for the critical aspects of the measurement effort, including:

- Sample collection, preservation, and storage;
- Calibration of instrumentation and apparatus;

- Data reduction, validation, and reporting;
- Documentation and sample custody; and
- Analytical quality control.

These protocols were tailored such that careful adherence to the prescribed protocols would, in most cases, result in achievement of both sets of objectives.

The second purpose of this QA/QC program was to provide the mechanism for data quality assessment. Quality control data provide information for identifying and defining qualitative and quantitative limitations associated with the measurement data. The following key types of QA/QC procedures provide the primary basis for quantitatively evaluating data quality:

- Field and laboratory blank samples;
- Spiked samples;
- Duplicate analyses; and
- Quality control check samples.

Blank samples play an especially important role in trace analysis efforts. They provide qualitative assurance that analytes detected in the samples were actually characteristic of the media sampled and not artifacts of the sampling and/or analytical process. Results are presented in the following sections for analysis of laboratory reagent blanks, field blanks, and TCLP extraction blanks.

Laboratory reagent blanks address only the analytical process. Typically included with each batch of samples analyzed, they provide an ongoing check of the analytical system for systematic sample contamination. When evidence of contamination is indicated by blank values above preestablished levels, corrective action was initiated to identify and eliminate the source of contamination. When possible, the affected samples were reanalyzed.

Field blanks reflect the combined effects of sample collection, handling, transportation, storage, and analysis. Since it is often not possible to resample when field blanks indicate possible sample contamination, field blank data are more often used to define qualitative limitations of the associated measurement data. The presence of analytes of interest in either the field or laboratory blanks suggests that corresponding field samples may have been similarly contaminated and that results for these analytes should be considered suspect. If the blank data show a given analyte at widely varying concentrations, or at concentrations comparable to those for field samples, then the field sample results should be viewed as possible false positives for that analyte. If, on the other hand, blank data indicate a given analyte at concentrations much lower than typical sample concentrations, then the sample data may usually be viewed as qualitatively reliable, but as having quantitative uncertainty which is greater than normal.

TCLP extraction blanks provide information related to contamination resulting from the TCLP process. Analytes found in TCLP blanks should be considered when interpreting results for TCLP extracts of field samples.

Two special types of spiked samples are used as part of the analytical protocol for analysis of organic compounds by gas chromatography. These are matrix spiked samples and surrogate spiked samples. Matrix spiked samples are field samples to which known amounts of the analytes of interest have been added. Typically, both a spiked and an unspiked aliquot of the sample are analyzed. The difference in results for the two analyses are calculated and compared to the amount of spike added. Since actual samples are used for the determination, any matrix effects are taken into consideration. Usually expressed as a percentage of the spike amount, spike recovery provides a measure of the accuracy of the analysis. For a single sample, this includes the combined effects of bias, or systematic error, and variability due to imprecision. Averaging spike recoveries for multiple samples tends to "average out" the random error due to imprecision and provides an estimate of analytical bias.

Surrogate spiked samples are similar to normal spiked samples except that an unspiked aliquot is not analyzed. Instead, samples are spiked with a mixture of surrogate compounds that are chemically similar to the species of interest but are not expected to be present in actual field samples. Recovery of these surrogate compounds provides an estimate of the accuracy of the method during that single analysis.

Duplicate samples and duplicate analyses are used as indicators of measurement data precision. Precision is a measure of mutual agreement among individual measurements of the same property made under prescribed similar conditions. Variability among the measurements is attributable to random error due to imprecision. In the case of duplicate analyses, the analytical process is replicated for separate aliquots of a single sample with prescribed elements of the process held constant. For example, duplicate analyses are usually performed on the same day, by the same analyst, using the same instrument and the same calibration. Differences in results for duplicate analyses are attributable to random variability in the analytical process and are a measure of analytical precision.

Duplicate samples provide another measure of precision. The analysis of duplicate samples involves replicating sample collection (and associated sample handling activities) as well as analysis. Precision estimates based on duplicate sample results incorporate imprecision due to sampling variability and analytical variability.

Both duplicate sample and duplicate analysis results provide data for precision estimates. Generally, however, duplicate sample data are used in a different way than results for duplicate analyses. Since analytical precision is primarily a function of the analytical procedures used, results for duplicate analyses may be used as an ongoing quality control check. Corrective action can be initiated when results indicate that analytical precision is not within acceptable limits. Results for duplicate samples, on the other hand, are more often used as a data quality assessment tool. Because of the lag between sample collection and availability of analytical results, it is usually not possible to initiate corrective action based on duplicate sample data. Also, variability in duplicate sample results typically includes a component of variability attributable to inherent nonhomogeneity of the sample matrix. Duplicate data of both types are useful as indicators of the degree to which results may be expected to vary by chance alone. This information is important whenever comparisons are made between measured values. Without it, it is difficult to know when to attribute observed differences to random measurement error and when to attribute them to acute differences.

For organic analyses, it is often the case that detectable levels of target analytes are not found in duplicate sample pairs, which precludes developing estimates of measurement variability. In this report, matrix spike duplicate results are used to assess repeatability. This is expressed as the relative percent difference (RPD) between duplicate spiked sample recoveries. The range of surrogate spike recoveries for a given matrix also provide a measure of analytical precision, expressed in terms of the standard deviation of percent recovery.

Quality control check samples (QCCS) are used to assess analytical performance under a given set of standard conditions. These are synthetic samples containing some or all of the analytes of interest at known concentrations and prepared independently from calibration standards. Typically analyzed with each set of analyses, QCCS results are often used as a real-time check of analytical system performance by comparing measured values to pre-established acceptability limits. Quality control check sample results may also be used to estimate analytical bias and accuracy by comparing measured results to theoretical concentrations. Although they do not address matrix effects like results for spiked samples, they do allow day-to-day variability to be considered and are useful in identifying trends.

The quality control results are summarized and discussed in the following sections.

3.1 QA/QC Results for PCB Analyses

The QA/QC efforts associated with PCB analyses included daily calibration verification, blank sample analyses, duplicate analyses, and matrix and surrogate spike analyses. Following initial multipoint calibration, the system was checked daily for continuing calibration. As part of the daily calibration verification, a single point calibration standard was analyzed, with agreement within 15 percent of the multipoint response required for analyses to proceed.

3.1.1 Blank Sample Analyses

Analyses of laboratory blank samples showed no PCBs above the reported detection limits. There was no evidence of contamination of field samples with PCBs resulting from the sampling/analysis process.

3.1.2 Spiked Sample Analyses

Matrix spike/matrix spike duplicate (MS/MSD) results are summarized in Tables 3-1, 3-2, and 3-3 for solid, aqueous, and ambient air samples analyzed for PCBs. These results provide a measure of accuracy (mean percent recovery) and precision (relative percent difference). The objectives for MS/MSD results were 50 to 150 percent recovery and 50 percent RPD. Almost half the recoveries for solid samples were outside the accuracy objective, but most were within the precision objective. Mean recoveries for matrix spike duplicate pairs ranged from 23 to 188 percent for solid waste feed, scrubber solids, and ash samples, and from 32 to 73 percent for scrubber effluent samples. Recovery of PCBs in a spiked ambient air blank sample ranged from 50 to 108 percent. Recoveries outside the 50 to 150 percent objective reflect interferences in the sample matrices which affected analyte quantitation.

Surrogate spike recoveries are summarized in Tables 3-4 through 3-7. Four ^{13}carbon-labeled chlorinated biphenyls were added to samples to check

TABLE 3-1. SUMMARY OF MATRIX SPIKE RECOVERIES FOR SOLID SAMPLES ANALYZED FOR PCBS

Compound	8/3-4 MS (% Rec)	8/3-4 MSD (% Rec)	Mean (% Rec)	RPD (%)
Solid Waste Feed				
Monochlorobiphenyl	210	165	188	24.0
Dichlorobiphenyl	83	96	90	14.5
Trichlorobiphenyl	107	123	115	13.9
Tetrachlorobiphenyl	131	75	103	54.4
Pentachlorobiphenyl	57	60	59	5.1
Hexachlorobiphenyl	120	153	137	24.2
Heptachlorobiphenyl	169	169	169	0.0
Octachlorobiphenyl	84	75	80	11.3
Decachlorobiphenyl	60	70	65	15.4
Scrubber Solids				
Monochlorobiphenyl	63	65	64	3.1
Dichlorobiphenyl	37	39	38	5.3
Trichlorobiphenyl	57	61	59	6.8
Tetrachlorobiphenyl	40	55	48	31.6
Pentachlorobiphenyl	25	26	26	3.9
Hexachlorobiphenyl	41	40	41	2.5
Heptachlorobiphenyl	46	46	46	0.0
Octachlorobiphenyl	37	33	35	11.4
Decachlorobiphenyl	40	40	40	0.0
Ash				
Monochlorobiphenyl	22	23	23	4.4
Dichlorobiphenyl	23	37	30	46.7
Trichlorobiphenyl	70	86	78	20.5
Tetrachlorobiphenyl	57	76	67	28.6
Pentachlorobiphenyl	53	61	57	14.0
Hexachlorobiphenyl	82	97	90	16.8
Heptachlorobiphenyl	82	86	84	4.8
Octachlorobiphenyl	67	63	65	6.2
Decachlorobiphenyl	34	34	34	0.0

TABLE 3-2. SUMMARY OF MATRIX SPIKE RECOVERIES FOR SCRUBBER EFLUENT ANALYZED FOR PCBS

Compound	MS (% Rec)	MSD (% Rec)	Mean (% Rec)	RPD (%)
Scrubber Effluent				
Monochlorobiphenyl	35	71	53	67.9
Dichlorobiphenyl	25	51	38	68.4
Trichlorobiphenyl	35	76	56	73.9
Tetrachlorobiphenyl	35	64	50	58.6
Pentachlorobiphenyl	22	42	32	62.5
Hexachlorobiphenyl	38	75	57	65.5
Heptachlorobiphenyl	54	91	73	51.0
Octachlorobiphenyl	56	78	67	32.8
Decachlorobiphenyl	54	76	65	33.8

TABLE 3-3. SUMMARY OF MATRIX SPIKE RECOVERIES FOR AMBIENT AIR SAMPLES ANALYZED FOR PCBS

Compound	MS (% Rec)	MSD (% Rec)	Mean (% Rec)	RPD (%)
Blank				
Monochlorobiphenyl	86	90	88	4.5
Dichlorobiphenyl	56	56	56	0.0
Trichlorobiphenyl	91	95	93	4.3
Tetrachlorobiphenyl	79	84	82	6.1
Pentachlorobiphenyl	50	50	50	0.0
Hexachlorobiphenyl	84	86	85	2.4
Heptachlorobiphenyl	108	108	108	0.0
Octachlorobiphenyl	75	76	76	1.3
Decachlorobiphenyl	92	100	96	8.3

TABLE 3-4. SUMMARY OF SURROGATE SPIKE RECOVERIES FOR SOLID SAMPLES ANALYZED FOR PCBS

Compound	8/3-4 (% Rec)	8/3-4 (% Rec)	Mean (% Rec)	Std Dev (%)
Solid Waste Feed				
^{13}C-Monochlorobiphenyl	61	57	59	2.8
^{13}C-Tetrachlorobiphenyl	42	85	64	30.4
^{13}C-Octachlorobiphenyl	0	0	0	0.0
^{13}C-Decachlorobiphenyl	0	0	0	0.0
Scrubber Solids				
^{13}C-Monochlorobiphenyl	89	85	87	2.8
^{13}C-Tetrachlorobiphenyl	91	91	91	0.0
^{13}C-Octachlorobiphenyl	75	74	75	0.7
^{13}C-Decachlorobiphenyl	67	73	70	4.2
Ash				
^{13}C-Monochlorobiphenyl	37	45	41	5.7
^{13}C-Tetrachlorobiphenyl	77	95	86	12.7
^{13}C-Octachlorobiphenyl	68	64	66	2.8
^{13}C-Decachlorobiphenyl	27	28	28	0.7

TABLE 3-5. SUMMARY OF SURROGATE SPIKE RECOVERIES FOR AQUEOUS SAMPLES ANALYZED FOR PCBS

Compound	8/1 (% Rec)	8/2 (% Rec)	8/3-4D (% Rec)	Mean (% Rec)	Std Dev
Scrubber Effluent					
^{13}C-Monochlorobiphenyl	52	50	47	50	2.5
^{13}C-Tetrachlorobiphenyl	80	78	69	76	5.9
^{13}C-Octachlorobiphenyl	91	96	86	91	5.0
^{13}C-Decachlorobiphenyl	110	106	96	104	7.2
Make-up Water					
^{13}C-Monochlorobiphenyl	48	50		49	2.9
^{13}C-Tetrachlorobipheny	77	82		80	4.4
^{13}C-Octachlorobiphenyl	83	84		84	0.8
^{13}C-Decachlorobiphenyl	98	98		98	0.0
Reagent Blank					
^{13}C-Monochlorobiphenyl	57	56		56	1.3
^{13}C-Tetrachlorobiphenyl	79	85		82	5.2
^{13}C-Octachlorobiphenyl	104	94		99	7.1
^{13}C-Decachlorobiphenyl	116	115		116	0.6

TABLE 3-6. SUMMARY OF SURROGATE SPIKE RECOVERIES FOR AMBIENT AIR SAMPLES ANALYZED FOR PCBs

Compound	7/31 upwind (% Rec)	7/31 downwind (% Rec)	8/1 upwind (% Rec)	8/1 downwind (% Rec)	8/2 upwind (% Rec)	8/2 downwind (% Rec)	8/3 upwind (% Rec)	8/3 downwind (% Rec)	8/4 upwind (% Rec)	8/4 downwind (% Rec)	Mean (% Rec)	Std Dev (%)
^{13}C-Monochloro-biphenyl	81	111	116	98	98	78	101	64	56	123	93	22.2
^{13}C-Tetrachloro-biphenyl	78	102	107	102	99	85	101	87	66	112	94	14.4
^{13}C-Octachloro-biphenyl	72	90	98	78	82	97	105	72	60	109	86	16.0
^{13}C-Decachloro-biphenyl	73	112	94	74	68	74	109	81	69	145	90	25.2

TABLE 3-7. SUMMARY OF SURROGATE SPIKE RECOVERIES FOR AMBIENT AIR BLANK SAMPLES ANALYZED FOR PCBs

Compound	MS Blank (% Rec)	MSD Blank (% Rec)	Field Blank (% Rec)	Field Blank (% Rec)	Lab Blank (% Rec)	Lab Blank (% Rec)	Lab Blank (% Rec)	Mean (% Rec)	Std Dev (%)
^{13}C-Monochlorobiphenyl	91	94	76	88	87	88	80	86	6.2
^{13}C-Tetrachlorobipheny	101	98	92	98	102	98	112	100	6.1
^{13}C-Octachlorobiphenyl	103	105	96	106	100	106	126	106	9.5
^{13}C-Decachlorobiphenyl	99	114	94	102	109	102	119	106	8.8

recoveries in individual samples. These results are generally within expected limits, with some exceptions. The octa- and deca-chlorobiphenyl surrogate spike compounds were not recovered in solid waste feed samples, indicating matrix interferences. Other recoveries in solid samples ranged from 28 to 91 percent, with eight out of ten within the recovery objective of 50 to 150 percent. The average surrogate recoveries in aqueous samples ranged from 49 to 116 percent. The average surrogate recoveries ranged from 86 to 94 percent in ambient air samples, and from 86 to 106 percent in ambient air blank samples. Precision was very good, ranging from zero to 30 percent, expressed as the standard deviation of percent recoveries of surrogate spikes.

3.2 QA/QC Results for PCDD/PCDF Analyses

Polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were analyzed according to procedures outlined in EPA Method 8280. Mass calibration of the instrument was performed daily with perfluorotributylamine and verified using decafluorotriphenylphosphine (DFTPP) ion abundance criteria and isotopic ratio criteria for PCDDs and PCDFs. Since selected-ion-monitoring mass spectrometry was used for PCDD/PCDF analysis, retention time windows were determined for each isomer group by injection of a PCDD/PCDF retention time standard containing the first and last eluter from each isomer group. A tetrachloro dibenzodioxin (TCDD) chromatographic performance check mixture was analyzed daily to verify a minimum 25 percent valley resolution between 2,3,7,8-TCDD and 1,2,3,3-TCDD.

Response factors for each PCDD/PCDF isomer class were determined from a five point calibration, performed in triplicate. The average response factors for each isomer class were required to have a percent RSD less than 15 percent. Quantitation was based on a ^{13}carbon internal standard for each isomer class.

3.2.1 Blank Sample Analyses

Blank sample results indicated no PCDD or PCDF contamination resulting from sample collection, handling or analysis.

3.2.2 Spiked Sample Analyses

Surrogate spike recoveries for PCDD and PCDF analyses are summarized in Tables 3-8 and 3-9 for solid and aqueous phase samples. Isotopically labeled PCDDs and PCDFs were used to check recovery and to provide an assessment of measurement variability. Spike recoveries were within the accuracy objective of 50 to 150 percent for most samples, but zero percent recoveries were observed in several cases. Recoveries of the heavier PCDD and PCDF surrogate standards were very low for certain solid waste feed and scrubber solids samples, indicating matrix effects. Surrogate spike recoveries in a reagent blank ranged from 73 to 110 percent, indicating acceptable analytical performance.

Average spike recoveries in scrubber water samples were within expected limits, ranging from 49 to 86 percent in scrubber effluent, and from 16 to 71 percent in make-up water. The low (16 percent) spike recovery in the make-up water is for the hexachlorodibenzofuran isomer class. Precision was excellent, ranging from five to 12 percent standard deviation of percent recovery. Spike recoveries in a water blank ranged from 40 to 77 percent.

3.3 QA/QC Results for Semivolatile Organics Analyses

Semivolatile extracts were analyzed using gas chromatography/mass spectrometry procedures described in EPA Method 8270. Identification and quantitation were performed using response factors and retention times generated from a five point calibration curve, relative to the closest eluting of six internal standards. The mass spectrometer was tuned daily to give an acceptable spectrum for DFTPP. System performance was verified initially and after every 12 hours to ensure a minimum average response factor of 0.050 four system performance check compounds. A five point calibration, used for generating response factors, was performed initially using 13 calibration check compounds representing base/neutral and acid extractable organics. A

TABLE 3-8. SURROGATE SPIKE RECOVERIES FOR SOLID SAMPLES ANALYZED FOR DIOXINS/FURANS

Compound	8/1	8/2	8/3-4	8/3-4D	Mean (% Rec)	Std Dev
Solid Waste Feed						
13C-2,3,7,8-TCDD	86	84	72	71	78	7.8
13C-2,3,7,8-TCDF	120	86	84	80	93	18.5
13C-1,2,3,7,8-PCDD	97	85	79	73	84	10.2
13C-1,2,3,7,8-PCDF	120	82	75	81	90	20.6
13C-1,2,3,6,7,8-HxCDD	NR	86	87	NR	43	49.9
13C-1,2,3,6,7,8-HxCDF	NR	71	79	NR	38	43.4
Scrubber Solids						
13C-2,3,7,8-TCDD	74	2	78	83	59	38.3
13C-2,3,7,8-TCDF	89	5	87	81	66	40.5
13C-1,2,3,7,8-PCDD	14	NR	21	12	12	8.7
13C-1,2,3,7,8-PCDF	10	NR	NR	10	5	5.8
13C-1,2,3,6,7,8-HxCDD	12	NR	17	7	9	7.3
13C-1,2,3,6,7,8-HxCDF	NR	NR	NR	NR	0	0.0
Ash						
13C-2,3,7,8-TCDD	84	94	80	83	85	6.1
13C-2,3,7,8-TCDF	110	100	84	91	96	11.3
13C-1,2,3,7,8-PCDD	71	100	78	86	84	12.4
13C-1,2,3,7,8-PCDF	72	88	78	85	81	7.2
13C-1,2,3,6,7,8-HxCDD	NR	160	100	120	95	68.1
13C-1,2,3,6,7,8-HxCDF	52	110	74	110	87	28.6

(Continued)

TABLE 3-8. (Continued)

Compound	8/1	8/2	8/3-4	8/3-4D	Mean (% Rec)	Std Dev
Reagent Blank						
13C-2,3,7,8-TCDD	75					
13C-2,3,7,8-TCDF	72					
13C-1,2,3,7,8-PCDD	79					
13C-1,2,3,7,8-PCDF	73					
13C-1,2,3,6,7,8-HxCDD	77					
13C-1,2,3,6,7,8-HxCDF	110					

NR - Surrogate not recovered.

TABLE 3-9. SUMMARY OF SURROGATE SPIKE RECOVERIES FOR AQUEOUS SAMPLES ANALYZED FOR DIOXINS AND FURANS

Compound	Sample					Mean (% Rec)	Std Dev
	8/1	8/2	8/3-4	8/3-4D	8/14		
Scrubber Effluent							
13C-2,3,7,8-TCDD	72	89	83	76		80	7.5
13C-2,3,7,8-TCDF	74	91	89	89		86	7.9
13C-1,2,3,7,8-PCDD	66	76	70	67		70	4.5
13C-1,2,3,7,8-PCDF	64	76	66	65		68	5.6
13C-1,2,3,6,7,8-HxCDD	53	60	50	48		53	5.3
13C-1,2,3,6,7,8-HxCDF	52	62	50	33		49	12.0
Makeup Water							
13C-2,3,7,8-TCDD					71		
13C-2,3,7,8-TCDF					75		
13C-1,2,3,7,8-PCDD					57		
13C-1,2,3,7,8-PCDF					50		
13C-1,2,3,6,7,8-HxCDD					41		
13C-1,2,3,6,7,8-HxCDF					16		
Water Blank							
13C-2,3,7,8-TCDD					74		
13C-2,3,7,8-TCDF					77		
13C-1,2,3,7,8-PCDD					70		
13C-1,2,3,7,8-PCDF					40		
13C-1,2,3,6,7,8-HxCDD					63		
13C-1,2,3,6,7,8-HxCDF					64		

continuing calibration check was performed every 12 hours using the calibration check compounds. The response factor for each calibration check compound was required to be within 30 percent of the average five-point response factor, or a new multipoint calibration curve was generated.

3.3.1 Blank Sample Analyses

Blank sample results showed not detectable semivolatile organic contaminants resulting from sample collection, handling or analysis, with the exception of low levels of diakyl phthalates, which are a common laboratory contaminant.

3.3.2 Spiked Sample Analyses

Matrix spike results for semivolatile organic analyses are summarized in Tables 3-10 through 3-13. These results show all matrix spike recoveries within the 50 to 150 percent objective for scrubber solids and scrubber effluent samples. In filter solids and ash samples, matrix spike recoveries were very low for pentachlorophenol, and in ash samples, n-nitroso-di-n-propylamine and 2,3-dinitrotoluene were not recovered at all. Recoveries were below 50 percent for several other spike compounds in the filter and ash samples, as shown in Tables 3-11 and 3-12.

Each of the matrix spike analyses was performed in duplicate. Precision estimates, based on the duplicate recovery data was very good (less than 20 percent RPD) for scrubber solids and effluent samples. Variability was higher in ash samples, ranging from zero to 37 percent RPD, but was within the laboratory precision objective of 50 percent RPD. Variability was very high in filter solids, ranging from 3 to 200 percent RPD. This is not unexpected, however, due to the heterogeneous nature of filter samples.

Surrogate spike recovery data for semivolatile organics is summarized in Tables 3-14 through 3-20. These results show the mean surrogate

TABLE 3-10. MATRIX SPIKE RECOVERIES FOR SCRUBBER SOLIDS ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	MS	MSD	Mean (% Rec)	RPD (%)
Scrubber Solids				
1,2,4-Trichlorobenzene	82	88	85	7.1
Acenaphthene	76	78	77	2.6
2,4-Dinitrotoluene	69	84	77	19.6
Pyrene	100	82	91	19.8
N-Nitroso-di-n-Propylamine	96	81	89	16.9
1,4-Dichlorobenzene	84	85	85	1.2
Pentachlorophenol	58	68	63	15.9
Phenol	95	85	90	11.1
2-Chlorophenol	87	89	88	2.3
4-Chloro-3-Mehtylphenol	88	90	89	2.2
4-Nitrophenol	81	88	85	8.3

MS - Matrix Spike
MSD - Matrix Spike Duplicate

TABLE 3-11. MATRIX SPIKE RECOVERIES FOR FILTER SAMPLES ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	MS	MSD	Mean (% Rec)	RPD (%)
Filter Solids				
1,2,4-Trichlorobenzene	5	56	31	167.2
Acenaphthene	41	60	51	37.6
2,4-Dinitrotoluene	57	66	62	14.6
Pyrene	79	77	78	2.6
N-Nitroso-di-n-Propylamine	8	63	36	152.4
1,4-Dichlorobenzene	0	36	18	200.0
Pentachlorophenol	1	4	2	111.1
Phenol	33	59	46	56.5
2-Chlorophenol	17	59	38	110.5
4-Chloro-3-Mehtylphenol	62	58	60	6.7
4-Nitrophenol	40	50	45	22.2

MS - Matrix Spike
MSD - Matrix Spike Duplicate

TABLE 3-12. MATRIX SPIKE RECOVERIES FOR ASH SAMPLES ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	MS	MSD	Mean (% Rec)	RPD (%)
Ash				
1,2,4-Trichlorobenzene	52	46	49	12.2
Acenaphthene	62	50	56	21.4
2,4-Dinitrotoluene	0	0	0	0.0
Pyrene	73	60	67	19.5
N-Nitroso-di-n-Propylamine	0	0	0	0.0
1,4-Dichlorobenzene	42	29	36	36.6
Pentachlorophenol	8	6	7	34.5
Phenol	40	30	35	28.6
2-Chlorophenol	58	43	51	29.7
4-Chloro-3-Methylphenol	82	77	80	6.3
4-Nitrophenol	25	21	23	17.4

MS - Matrix Spike
MSD - Matrix Spike Duplicate

TABLE 3-13. MATRIX SPIKE RECOVERIES FOR SCRUBBER EFFLUENT ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	MS	MSD	Mean (% Rec)	RPD (%)
Scrubber Effluent				
1,2,4-Trichlorobenzene	82	86	84	4.8
Acenaphthene	76	88	82	14.6
2,4-Dinitrotoluene	67	62	65	7.8
Pyrene	92	84	88	9.1
N-Nitroso-di-n-Propylamine	96	87	92	9.8
1,4-Dichlorobenzene	85	77	81	9.9
Pentachlorophenol	67	78	73	15.2
Phenol	96	101	99	5.1
2-Chlorophenol	87	92	90	5.6
4-Chloro-3-Mehtylphenol	90	90	90	0.0
4-Nitrophenol	78	87	83	10.9

MS - Matrix Spike
MSD - Matrix Spike Duplicate

TABLE 3-14. SURROGATE SPIKE RECOVERIES FOR SCRUBBER SOLIDS ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	PO-869	PO-843	PO-856	PO-881	PO-881-MS	PO-881-MSD	PO-908	Mean (% Rec)	Std Dev
Scrubber Solids									
2-Fluorophenol	88	91	95	92	96	98	79	91	6.4
Phenol-d5	101	95	114	105	108	99	86	101	9.1
Nitrobenzene-d5	95	88	99	95	100	94	95	95	3.9
2-Fluorobiphenyl	87	92	95	91	94	94	97	93	3.2
2,4,6-Tribromophenol	52	72	57	54	59	80	63	62	10.2
Terphenyl-d14	69	87	69	65	68	82	81	74	8.6

TABLE 3-15. SURROGATE SPIKE RECOVERIES FOR FILTER SAMPLES ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	PO-153-158	PO-412-416	PO-610-617	PO-531-538	PO-628-630	PO-628-MS	PO-628-MSD	Mean (% Rec)	Std Dev
Filter Solids									
2-Fluorophenol	107	2.5	0	61	53	8	64	42	40.1
Phenol-d5	127	19	7.5	71	62	39	72	57	39.9
Nitrobenzene-d5	148	2.7	0	65	50	4	68	48	53.2
2-Fluorobiphenyl	144	22	17.5	81	62	39	81	64	43.8
2,4,6-Tribromophenol	91	78	53	58	50	9	13	50	30.5
Terphenyl-d14	146	68	73	69	56	64	60	77	31.1

TABLE 3-16. SURROGATE SPIKE RECOVERIES FOR ASH SAMPLES ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	PO-926	PO-941	PO-894	PO-908	PO-908	PO-908	PO-628-630	Mean (% Rec)	Std Dev
Ash									
2-Fluorophenol	31	33	26	35	36	27	25	30	4.5
Phenol-d5	48	55	38	57	69	45	45	51	10.2
Nitrobenzene-d5	1	2	5	1	24	1	42	11	16.1
2-Fluorobiphenyl	72	83	62	77	137	72	57	80	26.6
2,4,6-Tribromophenol	30	46	45	55	75	44	55	50	13.9
Terphenyl-d14	71	4	63	95	145	75	84	77	42.0

TABLE 3-17. SURROGATE SPIKES RECOVERIES FOR SCRUBBER EFFLUENT SAMPLES ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	PO-244	PO-608	PO-595-596	PO-644-645	PO-273.49-279.27	PO-663-664	Mean (% Rec)	Std Dev
Scrubber Effluent								
2-Fluorophenol	94	83	82	95	99	95	91	7.1
Phenol-d5	102	85	85	107	110	108	100	11.5
Nitrobenzene-d5	96	93	78	100	103	99	95	8.9
2-Fluorobiphenyl	87	80	83	89	92	83	86	4.5
2,4,6-Tribromophenol	59	69	60	64	59	50	60	6.3
Terphenyl-d14	73	76	69	72	77	76	74	3.1

TABLE 3-18. SURROGATE SPIKE RECOVERIES FOR TCLP LEACHATES OF SOLID WASTE FEED ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	PO-806	PO-820	PO-829	PO-836	Mean (% Rec)	Std Dev
TCLP Solid Waste Feed						
2-Fluorophenol	84	81	84	85	84	1.7
Phenol-d5	85	80	79	89	83	4.6
Nitrobenzene-d5	95	89	92	92	92	2.4
2-Fluorobiphenyl	97	92	91	89	92	3.4
2,4,6-Tribromophenol	104	96	110	112	106	7.2
Terphenyl-d14	70	63	64	66	66	3.1

TABLE 3-19. SURROGATE SPIKE RECOVERIES FOR TCLP LEACHATES OF SCRUBBER SOLIDS ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	PO-847	PO-860	PO-860D	PO-873	PO-885	Mean (% Rec)	Std Dev
TCLP Scrubber Solids							
2-Fluorophenol	82	83	87	60	67	76	11.6
Phenol-d5	84	86	89	62	73	79	11.2
Nitrobenzene-d5	73	90	93	62	95	83	14.4
2-Fluorobiphenyl	103	93	97	65	97	91	15.0
2,4,6-Tribromophenol	44	115	113	71	110	91	31.7
Terphenyl-d14	82	76	76	49	80	73	13.4

TABLE 3-20. SURROGATE SPIKE RECOVERIES FOR TCLP LEACHATES OF ASH SAMPLES ANALYZED FOR SEMIVOLATILE ORGANICS

Compound	PO-898	PO-912	PO-930	PO-945	TCLP Blank	TCLP Blank	Reagent Blank	Reagent Blank	Mean (% Rec)	Std Dev
TCLP Ash										
2-Fluorophenol	72	87	77	82	66	94	83	71	79	9.3
Phenol-d5	73	87	81	85	69	97	85	71	81	9.5
Nitrobenzene-d5	79	91	79	88	67	96	87	70	82	10.2
2-Fluorobiphenyl	79	93	77	87	62	96	86	75	82	11.0
2,4,6-Tribromophenol	95	120	104	112	66	118	107	84	101	18.4
Terphenyl-d14	60	67	62	65	60	77	76	65	67	6.7

recoveries to be within the laboratory objective of 50 to 150 percent for most analyses. As with the matrix spike recoveries, the lowest overall recoveries and the largest variability were observed for filter and ash samples. For filter samples, the average recoveries ranged from 42 to 77 percent, and the standard deviation ranged from 30 to 50 percent. For ash samples, the average recoveries ranged from 11 to 80 percent, and the standard deviation ranged from four to 42 percent. The average surrogate recoveries for scrubber solids ranged from 62 to 101 percent, with the standard deviation of percent recoveries ranging from three to 10 percent. The average surrogate recoveries for scrubber effluent samples were also quite good, ranging from 60 to 100 percent, with the standard deviation ranging from three to 12 percent.

Surrogate spike recoveries in TCLP extracts were all within 50 to 150 percent, and the relative standard deviation of percent recoveries was less than 20 percent overall.

3.4 QA/QC Results for Volatile Organics Analyses

Samples for volatile organics were analyzed by scanning gas chromatography/mass spectrometry following EPA Method 8240. Analyte identification and quantitation were performed using response factors and retention times generated from a five point calibration curve, relative to the closest eluting of three internal standards. The mass spectrometer was tuned daily to give an acceptable spectrum for bromofluorobenzene (BFB). System performance was verified initially and after every 12 hours to ensure a minimum average response factor of 0.3 (0.25 for bromoform) for five system performance check compounds. A five point calibration, used for generating response factors, was performed initially using six calibration check compounds. A continuing calibration check was performed every 12 hours using the six calibration check compounds. The response factor for each calibration check compounds was required to agree within 25 percent of the average five-point response factor, or a new multipoint calibration curve was generated.

3.3.1 Blank Sample Analyses

Both laboratory and field blank sample results showed a consistent low level of methylene chloride associated with VOST sample analyses. The methylene chloride background was subtracted from the reported values for field samples. No other volatile organic contaminants were detected.

3.3.2 Spiked Sample Analyses

Matrix spike results for volatile organic analyses are summarized in Tables 3-21 through 3-24 These results show a wide range of recoveries, depending on the specific compound, for ash samples and for VOST samples. Mean spike recoveries ranged from seven to 40 percent for ash samples and from 24 to 183 percent for VOST samples. Matrix spike results for TCLP leachates of ash and scrubber effluent samples showed very good recoveries, which ranged from 76 to 108 percent for TCLP-ash, and from 84 to 108 for TCLP-scrubber effluent samples.

Repeatability of spike recovery data was within the laboratory objective of 50 percent RPD for all matrix spike duplicate results. These results ranged from seven to 40 percent RPD for ash samples, and even better for TCLP leachates, ranging from three to seven percent RPD for TCLP-ash and from zero to four percent RPD for TCLP-scrubber effluent samples. Matrix spike duplicate analyses were not performed for VOST samples; rather, three VOST samples were spiked. The relative standard deviation of percent recoveries ranged from four to 120 percent, which reflects the range of matrix spike recoveries in different samples rather than the repeatability of recovering a compound spiked into aliquots of the same sample.

Surrogate spike recovery data are summarized in Tables 3-25 through 3-30 for volatile organic analyses. These results show recoveries with the laboratory objective of 50 to 150 percent for most analyses. Notable exceptions include recovery of toluene-d_8 (210 percent) in ash samples, and ethylbenzene-d_{10} (169 percent) and p-bromofluorobenzene (206 percent) in VOST samples. The standard deviation of percent recoveries was less than 50

TABLE 3-21. MATRIX SPIKE RECOVERIES FOR ASH SAMPLES ANALYZED FOR VOLATILE ORGANICS

Compound	MS	MSD	Mean (% Rec)	RPD (%)
Ash				
1,1-Dichloroethene	180	120	150	40
Toluene	190	160	175	17
Chlorobenzene	80	92	86	14
Benzene	150	130	140	14
Trichloroethene	57	61	59	7

MS - Matrix Spike
MSD - Matrix Spike Duplicate

TABLE 3-22. MATRIX SPIKE RECOVERIES FOR TCLP LEACHATES OF ASH SAMPLES ANALYZED FOR VOLATILE ORGANICS

Compound	MS	MSD	Mean (% Rec)	RPD (%)
TCLP Ash				
1,1-Dichloroethene	92	99	96	7.3
Toluene	95	99	97	4.1
Chlorobenzene	94	90	92	4.3
Benzene	105	110	108	4.7
Trichloroethene	75	77	76	2.6

TABLE 3-23. MATRIX SPIKE RECOVERIES FOR TCLP LEACHATES OF SCRUBBER EFFLUENT ANALYZED FOR VOLATILE ORGANICS

Compound	MS	MSD	Mean (% Rec)	RPD (%)
TCLP Scrubber Effluent				
1,1-Dichloroethene	108	104	106	3.8
Toluene	96	100	98	4.1
Chlorobenzene	92	92	92	0.0
Benzene	108	108	108	0.0
Trichloroethene	84	84	84	0.0

TABLE 3-24. SUMMARY OF MATRIX SPIKE RECOVERIES FOR VOST SAMPLES ANALYZED FOR VOLATILES

Compound	8/4 (% Rec)	8/2 (% Rec)	8/5 (% Rec)	Mean (% Rec)	Std Dev
Chloromethane	160	240	54	151	93.3
Bromomethane	200	280	58	179	112.4
Vinyl Chloride	200	280	70	183	106.0
Chloroethane	180	280	42	167	119.5
Methylene chloride	130	140	60	110	43.6
Trichlorofluoromethane	140	130	68	113	39.0
1,1-Dichloroethene	86	130	44	87	43.0
1,1-Dichloroethane	90	180	110	127	47.3
trans-1,2-Dichloroethene	100	250	86	145	90.9
Chloroform	97	140	130	122	22.5
1,2-Dichloroethane	83	100	54	79	23.3
1,1,1-Trichloroethane	54	78	150	94	50.0
Carbon Tetrachloride	51	67	160	93	58.9
Bromodichloromethane	55	75	94	75	19.5
1,2-Dichloropropane	35	55	72	54	18.5
cis-1,3-Dichloropropene	42	48	62	51	10.3
Trichloroethene	46	61	72	60	13.1
Dibromochloromethane	45	49	65	53	10.6
1,1,2-Trichloroethane	39	45	51	45	6.0
Benzene	67	88	94	83	14.2
trans-1,3-Dichloropropene	42	56	72	57	15.0
Bromoform	33	33	47	38	8.1
Toluene	32	40	51	41	9.5
Tetrachloroethene	38	39	58	45	11.3
1,1,2,2-Tetrachloroethane	22	27	44	31	11.5
Chlorobenzene	35	38	47	40	6.2
o-Dichlorobenzene	21	21	29	24	4.6
m-Dichlorobenzene	22	23	32	26	5.5
p-Dichlorobenzene	23	22	30	25	4.4
Ethylbenzene	17	19	36	24	10.4

TABLE 3-25. SURROGATE SPIKE RECOVERIES FOR SOLID SAMPLES ANALYZED FOR VOLATILE ORGANICS

Compound	8/1	8/2	8/3	8/3-4	Mean (% Rec)	Std Dev
Solid Waste Feed						
Dichloroethane-d4	106	99	89	99	98	7.0
Toluene-d8	106	107	113	94	105	8.0
Bromofluorobenzene	48	41	64	45	50	10.1
Scrubber Solids						
Dichloroethane-d4	112	7	107	72	75	48.4
Toluene-d8	99	115	97	111	106	8.9
Bromofluorobenzene	81	104	78	103	92	13.9
Ash						
Dichloroethane-d4	73	92	98	99	91	12.1
Toluene-d8	200	270	190	180	210	40.8
Bromofluorobenzene	48	56	50	51	51	3.4
Reagent Blank						
Dichloroethane-d4	90					
Toluene-d8	92					
Bromofluorobenzene	96					

TABLE 3-26. SURROGATE SPIKE RECOVERIES FOR AQUEOUS SAMPLES ANALYZED FOR VOLATILE ORGANICS

Compound	8/1	8/2	8/3-4	8/3-4D	8/14	8/14	Mean (% Rec)	Std Dev
Scrubber Effluent								
Dichloroethane-d4	101	91	96	92			95	4.5
Toluene-d8	100	94	96	93			96	3.1
Bromofluorobenzene	114	95	95	96			100	9.3
VOST Condensate								
Dichloroethane-d4	91	101	99	115			102	10.0
Toluene-d8	94	90	94	97			94	2.9
Bromofluorobenzene	96	96	102	98			98	2.8
Makeup Water								
Dichloroethane-d4			91	102			97	7.8
Toluene-d8			96	90			93	4.2
Bromofluorobenzene			98	95			97	2.1

TABLE 3-27. SURROGATE SPIKE RECOVERIES FOR TCLP LEACHATES OF SOLIDS SAMPLES ANALYZED FOR VOLATILE ORGANICS

Compound	8/1	8/2	8/3	8/4	Mean (% Rec)	Std Dev
Solid Waste Feed						
Dichloroethane-d4	101	109	270	98	145	83.8
Toluene-d8	94	94	107	97	98	6.2
Bromofluorobenzene	82	82	87	80	83	3.0
Scrubber Solids						
Dichloroethane-d4	110	97	106	97	103	6.6
Toluene-d8	100	99	101	101	100	1.0
Bromofluorobenzene	81	86	84	82	83	2.2
Ash						
Dichloroethane-d4	93	100	94	94	95	3.2
Toluene-d8	106	103	102	103	104	1.7
Bromofluorobenzene	86	97	84	85	88	6.1
System Blank						
Dichloroethane-d4	104					
Toluene-d8	92					
Bromofluorobenzene	80					

TABLE 3-28. SURROGATE SPIKE RECOVERIES FOR TCLP LEACHATES OF LIQUID SAMPLES ANALYZED FOR VOLATILE ORGANICS

Compound	8/1	8/2	8/3-4	8/3-4D	8/14	8/14D	Mean (% Rec)	Std Dev
Scrubber Effluent								
Dichloroethane-d4	101	91	96	92			95	4.5
Toluene-d8	100	94	96	93			96	3.1
Bromofluorobenzene	114	95	95	96			100	9.3
Makeup Water								
Dichloroethane-d4					91	102	97	7.8
Toluene-d8					96	90	93	4.2
Bromofluorobenzene					98	95	97	2.1

TABLE 3-29. SUMMARY OF SURROGATE SPIKE RECOVERIES FOR VOST SAMPLES ANALYZED FOR VOLATILES

Compound	8/1 (% Rec)	8/1 (% Rec)	8/2 (% Rec)	8/2 (% Rec)	8/3-4 (% Rec)	8/3-4 (% Rec)	8/3-4 (% Rec)	8/3-4 (% Rec)	8/3-4 (% Rec)	8/3-4 (% Rec)	8/1 MS (% Rec)	8/2 MS (% Rec)	8/5 MS (% Rec)	Mean (% Rec)	Std Dev (%)
1,2-Dichloroethane-d4	101	112	50	113	109	111	125	104	98	99	112	120	103	104	18.2
Bromochloromethane	102	95	22	98	87	104	139	116	100	96	145	167	116	107	34.5
2-Bromo-1-chloropropane	88	133	164	49	127	149	38	134	107	91	48	43	53	94	44.6
Ethylbenzene-d10	143	261	452	208	251	279	51	157	143	149	37	28	35	169	122.5
p-Bromofluorobenzene	157	307	506	326	286	366	85	198	168	162	42	34	36	206	145.0

TABLE 3-30. SUMMARY OF SURROGATE SPIKE RECOVERIES FOR VOST BLANK SAMPLES ANALYZED FOR VOLATILES

Compound	Field Blank (% Rec)	Field Blank (% Rec)	Field Blank (% Rec)	Lab Blank (% Rec)	Lab Blank (% Rec)	Lab Blank (% Rec)	Mean (% Rec)	Std Dev (%)
1,2-Dichloroethane-d4	106	130	127	105	118	112	116	10.6
Bromochloromethane	93	164	134	189	120	120	137	34.5
2-Bromo-1-chloropropane	74	27	53	34	73	31	49	21.2
Ethylbenzene-d10	101	15	55	35	87	55	58	31.9
p-Bromofluorobenzene	67	94	55	30	95	42	64	26.8

percent for all compounds in solid samples. The standard deviation was less than 10 percent for all compounds in aqueous and TCLP leachate samples except dichloroethane-d_4 (84 percent standard deviation) in TCLP-solid waste feed. The standard deviation of surrogate spike recoveries in VOST samples ranged from 18 to 145 percent, which indicates a high degree of measurement variability for VOST samples. Table 3-30 shows surrogate spike recovery data for VOST blank samples analyzed for volatile organics. These results suggest that, even in the absence of sample matrix effects, that accuracy and precision for these analyses approach ±50 percent error and 50 percent standard deviation.

3.5 QA/QC Results for Metals Analyses

Samples for metals were analyzed using inductively coupled plasma emission (ICPES) or atomic absorption spectroscopy (AAS), following procedures described in EPA Method 6010 (ICPES) or 7000 series (AAS). Calibration for ICPES analyses was based on a response factor generated daily for each metal using three exposures of a calibration standard and calibration blank. Calibration was verified by analyzing a QC check standard after every 10 samples, with agreement with ±10 percent of the expected value required for continuing analysis. Calibration for AAS analyses was based on a multipoint calibration curve generated daily for each metal using a calibration blank and three upscale standards. AAS calibration was verified after every ten samples by analyzing a QC check standard, with agreement within ±15 percent of the expected value required for continuing analysis.

3.5.1 Blank Sample Analyses

Calibration blanks were analyzed every ten samples as part of the ongoing calibration verification procedure. Calibration blank results were required to be within five times the instrument detection limit, or the system was recalibrated. Laboratory reagent blanks were analyzed with each sample batch to assess background levels of analytes resulting from sample preparation, including addition of reagents and digestion. Reagent blank results for metals were subtracted from field sample results.

Three TCLP blanks were analyzed for metals. No significant contamination for the metals of interest was detected. Only arsenic and barium were found above the detection limits in the blank samples, and neither was detected at a concentration greater than twice the detection limit. The mean found concentrations in the TCLP blanks were 0.003 mg/L for arsenic and 0.012 mg/L for barium (compared with detection limits of 0.002 and 0.009 mg/L, respectively).

3.5.2 Spiked Sample Analyses

Matrix spike/matrix spike duplicate results for metals analyses are summarized in Tables 3-31 through 3-33 for metals analyses. Samples of each matrix type were spiked with known concentrations of target metals. Each matrix spike analysis was performed in duplicate. Recoveries within 75-125 percent of the theoretical value were expected, with repeatability of the spike recovery within 20 percent RPD. Recoveries outside the acceptance window were flagged in the data reports to indicate inaccuracies due to matrix interferences. Method spikes, i.e., reagent blanks spiked and treated as a normal sample were analyzed to verify analytical process control. Matrix spike results showed acceptable recoveries for all metals except selenium, iron, and lead. Matrix interferences prevented recovery in selenium solid waste feed, scrubber effluent, and TCLP leachate samples. The TCLP leachate sample was reanalyzed for selenium using the method of standard additions. Selenium was still not detected, but a verifiable detection limit for the metal was determined by this method. Recoveries of iron and lead were below the 75 percent objective due to matrix interferences, but were recoverable at about 55 percent, and the recoveries were repeatable. Overall, matrix spike duplicate results showed excellent repeatability, well within the precision objective of 20 percent RPD about 95 percent of the time.

TABLE 3-31. SUMMARY OF SPIKED SAMPLE RESULTS FOR SOLID SAMPLES ANALYZED FOR METALS

DATE	SAMPLE #	PARAM	SOURCE	MATRIX SPIKES Sample Result	Spike Result	Spike Added	Recov (% Rec)	MATRIX SPIKE DUPLICATES 1 (% Rec)	2 (% Rec)	RPD (%)
21-Sep-87	Method Spike	Ag		a	0.92	1.00	92			
21-Sep-87	PO-804	Ag	SWF 8/2	1.5	90	100	89	89	90	1.7
21-Sep-87	Method Spike	Al		a	9.41	10.0	94			
21-Sep-87	PO-804	Al	SWF 8/2	1680	2780	1000	110	110	64	52.9
18-Sep-87	PO-818	As	SWF 8/1	2.9	5	2.0	105	105	80	27.0
21-Sep-87	Method Spike	Ba		a	0.95	1.00	95			
21-Sep-87	Method Spike	Be		a	0.92	1.00	92			
21-Sep-87	PO-804	Be	SWF 8/2	0.11	92	100	92	92	92	0.1
21-Sep-87	Method Spike	Ca		a	9.59	10.0	96			
28-Sep-87	Method Spike	Cd		a	0.97	1.00	97			
28-Sep-87	PO-804	Cd	SWF 8/2	3.8	98	99	95	95	93	2.1
28-Sep-87	Method Spike	Co		a	0.98	1.00	98			
28-Sep-87	PO-804	Co	SWF 8/2	<4	93	99	94	94	95	1.1
21-Sep-87	Method Spike	Cr		a	0.93	1.00	93			
21-Sep-87	PO-804	Cr	SWF 8/2	23	111	100	88	88	86	2.3
21-Sep-87	Method Spike	Cu		a	0.9	1.00	90			
21-Sep-87	PO-804	Cu	SWF 8/2	50	132	100	82	82	82	0.0
21-Sep-87	Method Spike	Fe		a	9.41	10.0	94			
21-Sep-87	PO-804	Fe	SWF 8/2	2240	2840	1000	60	60	46	26.4
22-Sep-87	PO-818	Hg	SWF 8/1	<.05	0.9	1.0	90	90	100	10.5
21-Sep-87	Method Spike	Li		a	0.91	1.00	91			
21-Sep-87	PO-804	Li	SWF 8/2	<2	91	100	91	91	91	0.0
21-Sep-87	Method Spike	Mg		a	9.16	10.0	92			
21-Sep-87	PO-804	Mg	SWF 8/2	845	1730	1000	89	89	90	1.7
21-Sep-87	Method Spike	Mn		a	0.93	1.00	93			
21-Sep-87	PO-804	Mn	SWF 8/2	48	141	100	93	93	87	6.7
21-Sep-87	Method Spike	Na		a	9.92	10.0	99			
21-Sep-87	Method Spike	Ni		a	0.93	1.00	93			
21-Sep-87	PO-804	Ni	SWF 8/2	7.3	96	100	89	89	89	0.3

(Continued)

TABLE 3-31. (Continued)

				MATRIX SPIKES				MATRIX SPIKE DUPLICATES		
DATE	SAMPLE #	PARAM	SOURCE	SAMPLE RESULT	SPIKE RESULT	SPIKE ADDED	RECOV (% Rec)	1 (% Rec)	2 (% Rec)	RPD (%)
23-Sep-87	PO-818	Sb	SWF 8/1	2.2	6.2	5.0	80	80	66	19.2
18-Sep-87	PO-818	Se	SWF 8/1	<.3	<.3	2.0	0	0	0	0.0
21-Sep-87	Method Spike	Sr		a	0.96	1.00	96			
21-Sep-87	PO-804	Sr	SWF 8/2	57	145	100	88	88	86	2.3
28-Sep-87	Method Spike	Tl		a	1.06	1.00	106			
28-Sep-87	PO-804	Tl	SWF 8/2	<36	104	99	105	105	108	2.8
21-Sep-87	Method Spike	V		a	0.99	1.00	99			
21-Sep-87	PO-804	V	SWF 8/2	7.4	100	100	93	93	93	0.4
28-Sep-87	Method Spike	Zn		a	0.94	1.00	94			

TABLE 3-32. SUMMARY OF SPIKED SAMPLES RESULTS FOR AQUEOUS SAMPLES ANALYZED FOR METALS

				MATRIX SPIKES				MATRIX SPIKE DUPLICATES		
DATE	SAMPLE #	PARAM	SOURCE	SAMPLE RESULT (ppm)	SPIKED RESULT (ppm)	SPIKE ADDED (ppm)	RECOV (%)	1 (% Rec)	2 (% Rec)	RPD (%)
23-Sep-87	Method Spike	Ag		–[a]	0.95	1.00	95			
23-Sep-87	PO-242	Ag	ScrEff 8/1	<.009	0.9	1.00	90	90	91	1.1
23-Sep-87	Method Spike	Al		–[a]	9.3	10.0	93			
23-Sep-87	PO-242	Al	ScrEff 8/1	1.1	10	10.0	89	89	89	0.0
14-Sep-87	Method Spike	As		–[a]	0.018	0.020	90			
14-Sep-87	PO-597	As	ScrEff 8/3-4	0.038	0.052	0.020	70	70	70	0.0
23-Sep-87	Method Spike	B		–[a]	0.97	1.00	97			
23-Sep-87	PO-242	B	ScrEff 8/1	<.6	1.22	1.00	122	122	117	4.2
23-Sep-87	Method Spike	Ba		–[a]	0.92	1.00	92			
23-Sep-87	PO-242	Ba	ScrEff 8/1	0.12	0.98	1.00	86	86	86	0.0
23-Sep-87	Method Spike	Be		–[a]	0.92	1.00	92			
23-Sep-87	PO-242	Be	ScrEff 8/1	<.001	0.89	1.00	89	89	88	1.1
23-Sep-87	Method Spike	Ca		–[a]	9.4	10.0	94			
23-Sep-87	PO-242	Ca	ScrEff 8/1	56	64	10.0	80	80	80	0.0
23-Sep-87	Method Spike	Cd		–[a]	0.91	1.00	91			
23-Sep-87	PO-242	Cd	ScrEff 8/1	0.004	0.85	1.00	85	85	84	0.7
23-Sep-87	Method Spike	Co		–[a]	0.90	1.00	90			
23-Sep-87	PO-242	Co	ScrEff 8/1	<.01	0.85	1.00	85	85	84	1.2
23-Sep-87	Method Spike	Cr		–[a]	0.91	1.00	91			
23-Sep-87	PO-242	Cr	ScrEff 8/1	<.009	0.86	1.00	86	86	85	1.2
23-Sep-87	Method Spike	Cu		–[a]	0.90	1.00	90			
23-Sep-87	PO-242	Cu	ScrEff 8/1	0.039	0.88	1.00	84	84	85	1.1
23-Sep-87	Method Spike	Fe		–[a]	9.2	10.0	92			
23-Sep-87	PO-242	Fe	ScrEff 8/1	<.03	8.7	10.0	87	87	88	1.1
29-Aug-87	PO-242	Hg	ScrEff 8/1	<.0002	0.2	0.200	100			
23-Sep-87	Method Spike	Li		–[a]	0.93	1.00	93			
23-Sep-87	PO-242	Li	ScrEff 8/1	<.02	0.89	1.00	89	89	88	1.1
23-Sep-87	Method Spike	Mg		–[a]	9.2	10.0	92			
23-Sep-87	PO-242	Mg	ScrEff 8/1	2.5	11	10.0	85	85	85	0.0
23-Sep-87	Method Spike	Mn		–[a]	0.91	1.00	91			
23-Sep-87	PO-242	Mn	ScrEff 8/1	0.036	0.89	1.00	85	85	84	1.7
23-Sep-87	Method Spike	Na		–[a]	11	10.0	110			

(Continued)

TABLE 3-32. (Continued)

DATE	SAMPLE #	PARAM	SOURCE	MATRIX SPIKES SAMPLE RESULT (ppm)	SPIKED RESULT (ppm)	SPIKE ADDED (ppm)	RECOV (%)	MATRIX SPIKE DUPLICATES 1 (% Rec)	2 (% Rec)	RPD (%)
23-Sep-87	Method Spike	Ni		-[a]	0.9	1.00	90			
23-Sep-87	PO-242	Ni	ScrEff 8/1	0.033	0.87	1.00	84	84	84	0.4
29-Sep-87	Method Spike	Pb		-[a]	0.27	0.30	90			
14-Sep-87	Method Spike	Pb		-[a]	0.020	0.020	100			
29-Sep-87	PO-597	Pb	ScrEff 8/3-4	0.42	0.59	0.30	57	57	57	0.0
16-Sep-87	Method Spike	[illegible]		-[a]	0.049	0.050	98			
16-Sep-87	PO-597	Sb	ScrEff 8/3-4	0.014	0.052	0.050	76	76	76	0.0
14-Sep-87	Method Spike	Se		-[a]	0.017	0.020	85			
14-Sep-87	PO-597	Se	ScrEff 8/3-4	<.015	<.015	0.020	0	0	0	0.0
23-Sep-87	Method Spike	Sr		-[a]	0.94	1.00	94			
23-Sep-87	PO-242	Sr	ScrEff 8/1	0.086	0.97	1.00	88	88	87	1.6
23-Sep-87	Method Spike	Tl		-[a]	0.98	1.00	98			
23-Sep-87	PO-242	Tl	ScrEff 8/1	<.09	0.9	1.00	90	90	93	3.3
23-Sep-87	Method Spike	V		-[a]	0.92	1.00	92			
23-Sep-87	PO-242	V	ScrEff 8/1	0.029	0.91	1.00	88	88	87	1.3
23-Sep-87	Method Spike	Zn		-[a]	0.92	1.00	92			
23-Sep-87	PO-242	Zn	ScrEff 8/1	1.9	2.7	1.00	80	80	80	0.0

TABLE 3-33. SUMMARY OF SPIKED SAMPLE RESULTS FOR TCLP SAMPLES ANALYZED FOR METALS

ANALYSIS DATE	SAMPLE #	PARAM	SOURCE	MATRIX SPIKES Sample Result (ppm)	MATRIX SPIKES Spike Result (ppm)	MATRIX SPIKES Spike Added (ppm)	MATRIX SPIKES Recov (%)	MATRIX SPIKE DUPLICATES 1 (% Rec)	MATRIX SPIKE DUPLICATES 2 (% Rec)	MATRIX SPIKE DUPLICATES RPD (%)
23-Sep-87	Method Spike	Ag		[a]	0.95	1.00	95			
23-Sep-87	PO-806	Ag	SWF 8/2	0.016	0.93	1.00	91	91	91	0.0
14-Sep-87	Method Spike	As		[a]	0.018	0.020	90			
14-Sep-87	PO-820	As	SWF 8/1	0.007	0.023	0.020	80	80	75	6.5
23-Sep-87	Method Spike	Ba		[a]	0.92	1.00	92			
23-Sep-87	PO-806	Ba	SWF 8/2	0.14	0.99	1.00	85	85	88	3.5
23-Sep-87	Method Spike	Cd		[a]	0.91	1.00	91			
23-Sep-87	PO-806	Cd	SWF 8/2	0.021	0.83	1.00	81	81	83	2.6
23-Sep-87	Method Spike	Cr		[a]	0.91	1.00	91			
23-Sep-87	PO-806	Cr	SWF 8/2	0.014	0.84	1.00	83	83	86	4.0
14-Sep-87	PO-860	Hg	SS 8/3-4	<.0002	0.21	0.200	105	105	110	4.7
14-Sep-87	Method Spike	Pb		[a]	0.020	0.020	100			
29-Sep-87	Method Spike	Pb		[a]	7.6	8.0	95			
29-Sep-87	PO-820	Pb	SWF 8/1	8.6	16	8.0	93	92	92	0.0
14-Sep-87	Method Spike	Se		[a]	0.017	0.020	85			
14-Sep-87	PO-820	Se	SWF 8/1	<.075	<.075	0.020	0 MSA	0	0	0.0

---

[a] Blank result subtracted.

MSA-Sample reanalyzed using Method of Standard Additions.

3.5.3 Duplicate Analyses

Duplicate analysis results are summarized in Tables 3-34 through 3-37. Duplicate analyses for metals were performed on solid waste feed and scrubber effluent samples, and on TCLP leachates of waste feed, ash, and scrubber solids. A duplicate TCLP extraction was also performed on a scrubber solids sample. Precision, expressed as the RPD for duplicate analysis of samples split prior to digestion, ranged from zero to 94 percent for solid samples, from zero to 33 percent for aqueous samples, and from zero to 15 percent for TCLP leachates. The precision for duplicate TCLP extractions ranged from seven to 33 percent RPD. These precision estimates are typical for the matrix types, (e.g., larger variability for solid samples) and concentration levels.

3.6 QA/QC Results for Continuous Emission Monitors

Continuous emission monitoring systems (CEMs) were used to measure non-methane hydrocarbons, carbon dioxide, carbon monoxide, oxygen, and oxides of nitrogen in stack gases. Multipoint calibration data, single-point calibration verification data, and analytical and single point drift check data are presented in Tables 3-38 through 3-47. These results show the CEM systems to be properly calibrated and operating within acceptable limits during the monitoring period.

3.7 QA/QC Results for Solids Characterization

Samples of solid waste feed, ash, and scrubber solids were analyzed for proximate and ultimate parameters. Both field duplicate and laboratory duplicate samples were analyzed to assess measurement precision. Precision estimates for the solids characterization analyses are summarized in Table 3-48. These results show measurement variability within expected limits, and with no evidence of excessive imprecision due to analytical technique.

TABLE 3-34. SUMMARY OF DUPLICATE ANALYSIS RESULTS FOR SOLID SAMPLES ANALYZED FOR METALS

DATE	SAMPLE #	PARAM	SOURCE	1 (ppm)	2 (ppm)	RPD (%)
21-Sep-87	PO-818	Ag	SWF 8/1	2.1	2.1	0.0
21-Sep-87	PO-818	Al	SWF 8/1	1740	1780	2.3
21-Sep-87	PO-818	Ba	SWF 8/1	540	570	5.4
21-Sep-87	PO-818	Be	SWF 8/1	0.16	0.21	27.0
21-Sep-87	PO-818	Ca	SWF 8/1	38800	38400	1.0
21-Sep-87	PO-818	Cr	SWF 8/1	24	29	18.9
21-Sep-87	PO-818	Cu	SWF 8/1	55	54	1.8
21-Sep-87	PO-818	Fe	SWF 8/1	2140	2430	12.7
21-Sep-87	PO-818	Li	SWF 8/1	<1.9	<2.0	NC
21-Sep-87	PO-818	Mg	SWF 8/1	892	885	0.8
21-Sep-87	PO-818	Mn	SWF 8/1	52	83	45.9
21-Sep-87	PO-818	Mo	SWF 8/1	<4.8	<5.0	NC
21-Sep-87	PO-818	Na	SWF 8/1	2280	2330	2.2
21-Sep-87	PO-818	Ni	SWF 8/1	7.5	7.9	5.2
21-Sep-87	PO-818	P	SWF 8/1	691	756	9.0
21-Sep-87	PO-818	S	SWF 8/1	21700	21600	0.5
21-Sep-87	PO-818	Sr	SWF 8/1	62	65	4.7
21-Sep-87	PO-818	Ti	SWF 8/1	41	40	2.5
21-Sep-87	PO-818	V	SWF 8/1	8.5	7.9	7.3
28-Sep-87	PO-818	As	SWF 8/1	<120	<120	NC
28-Sep-87	PO-818	Cd	SWF 8/1	5.8	16	93.6
28-Sep-87	PO-818	Co	SWF 8/1	<4	<4	NC
28-Sep-87	PO-818	Pb	SWF 8/1	5270	5480	3.9
28-Sep-87	PO-818	Tl	SWF 8/1	<35	<36	NC
28-Sep-87	PO-818	Zn	SWF 8/1	1080	1240	13.8
23-Sep-87	PO-804	Sb	SWF 8/2	2.2	2	9.5
18-Sep-87	PO-804	As	SWF 8/2	2.8	2.1	28.6
18-Sep-87	PO-804	Se	SWF 8/2	<.3	<.3	NC
17-Sep-87	PO-804	Pb	SWF 8/2	5200	4650	11.2
22-Sep-87	PO-804	Hg	SWF 8/2	<.05	<.05	NC

TABLE 3-35. SUMMARY OF DUPLICATE ANALYSIS RESULTS FOR AQUEOUS SAMPLES ANALYZED FOR METALS

DATE	SAMPLE #	PARAM	SOURCE	1 (ppm)	2 (ppm)	RPD (%)
23-Sep-87	PO-609	Ag	ScrEff 8/2	<.009	<.009	NC
23-Sep-87	PO-609	Al	ScrEff 8/2	0.74	0.74	0.0
14-Sep-87	PO-242	As	ScrEff 8/1	0.1	0.1	0.0
23-Sep-87	PO-609	B	ScrEff 8/2	<.6	<.6	NC
23-Sep-87	PO-609	Ba	ScrEff 8/2	0.28	0.27	3.6
23-Sep-87	PO-609	Be	ScrEff 8/2	<.001	<.001	NC
23-Sep-87	PO-609	Ca	ScrEff 8/2	11	10	9.5
23-Sep-87	PO-609	Cd	ScrEff 8/2	<.003	0.005	NC
23-Sep-87	PO-609	Co	ScrEff 8/2	<.01	<.01	NC
23-Sep-87	PO-609	Cr	ScrEff 8/2	0.067	0.058	14.4
23-Sep-87	PO-609	Cu	ScrEff 8/2	0.057	0.052	9.2
23-Sep-87	PO-609	Fe	ScrEff 8/2	0.62	0.59	5.0
29-Aug-87	PO-242	Hg	ScrEff 8/1	<.0002	<.0002	NC
23-Sep-87	PO-609	Li	ScrEff 8/2	<.3	0.025	NC
23-Sep-87	PO-609	Mg	ScrEff 8/2	1.3	1.3	0.0
23-Sep-87	PO-609	Mn	ScrEff 8/2	0.004	<.003	NC
23-Sep-87	PO-609	Mo	ScrEff 8/2	<.05	<.05	NC
23-Sep-87	PO-609	Na	ScrEff 8/2	5070	5000	1.4
23-Sep-87	PO-609	Ni	ScrEff 8/2	<.02	<.02	NC
23-Sep-87	PO-609	P	ScrEff 8/2	1.4	1.9	30.3
14-Sep-87	PO-242	Pb	ScrEff 8/1	0.098	0.100	2.0
23-Sep-87	PO-609	S	ScrEff 8/2	710	700	1.4
16-Sep-87	PO-242	Sb	ScrEff 8/1	0.036	0.036	0.0
14-Sep-87	PO-242	Se	ScrEff 8/1	<.015	<.015	NC
23-Sep-87	PO-609	Si	ScrEff 8/2	9.7	9.6	1.0
23-Sep-87	PO-609	Sr	ScrEff 8/2	0.032	0.03	6.5
23-Sep-87	PO-609	Ti	ScrEff 8/2	0.14	0.1	33.3
23-Sep-87	PO-609	Tl	ScrEff 8/2	<.09	<.09	NC
23-Sep-87	PO-609	V	ScrEff 8/2	0.022	0.021	4.7
23-Sep-87	PO-609	Zn	ScrEff 8/2	0.14	0.13	7.4

NC - Not Calculable.

TABLE 3-36. SUMMARY OF DUPLICATE ANALYSIS RESULTS FOR TCLP SAMPLES ANALYZED FOR METALS

ANALYSIS DATE	SAMPLE #	PARAM	SOURCE	1 (ppm)	2 (ppm)	RPD (%)
23-Sep-87	PO-898	Ag	Ash 8/3-4	0.055	0.049	11.5
23-Sep-87	PO-898	Ba	Ash 8/3-4	0.27	0.27	0.0
23-Sep-87	PO-898	Cd	Ash 8/3-4	0.007	0.006	15.4
23-Sep-87	PO-898	Cr	Ash 8/3-4	0.037	0.032	14.5
14-Sep-87	PO-806	As	SWF 8/2	0.007	0.007	0.0
14-Sep-87	PO-806	Pb	SWF 8/2	2.6	2.3	12.2
14-Sep-87	PO-806	Se	SWF 8/2	<.003	<.003	NC
29-Sep-87	PO-860	Hg	SS 8/3-4	<.0002	<.0002	NC

TABLE 3-37. TCLP EXTRACTION DUPLICATES

	Detection Limit (mg/L)	Scrubber Solids 8/3-4 Extraction 1 (mg/L)	Extraction 2 (mg/L)	RPD (%)
Arsenic	0.002	0.015	0.014	6.9
Barium	0.009	.034	0.030	12.5
Cadmium	0.003	0.058	0.044	27.5
Chromium	0.009	0.027[a]	0.030[a]	10.5
Lead	0.002	0.30	0.34	12.5
Mercury	0.0002	ND	ND	--
Selenium	0.015	ND	ND	--
Silver	0.009	0.030[a]	0.042[a]	33.3

[a] Value is less than 5 times the detection limit.

TABLE 3-38. MULTIPOINT CALIBRATION AND CORRELATION COEFFICIENT

Site: Peak Oil
Operator: JRG
Date/Time: 7-31-87/0834

		Analytical Blank		Mid-Level Standard		High-Level Standard		
Monitor ID	Span Value	Reference Value	CEMS Response	Reference Value	CEMS Response	Reference Value	CEMS Response	Correlation Coefficient
NMHC	400 ppm	0	9	27.4	34	267	254	0.9999996
CO_2	20%	0	0.08	9.0	9.2	15.0	14.8	0.9998
CO	250 ppm	0	2.3	34	36	88	89	0.999996
O_2	25%	0	0.1	5.1	5.0	12.0	11.8	0.99997
NO_x	1000 ppm	0	0.5	344	340	500	480	0.9998

TABLE 3-39. MULTIPOINT CALIBRATION AND CORRELATION COEFFICIENT

Site: Peak Oil
Operator: JRG
Date/Time: 8-05-87/0930

Monitor ID	Span Value	Analytical Blank		Mid-Level Standard		High-Level Standard		Correlation Coefficient
		Reference Value	CEMS Response	Reference Value	CEMS Response	Reference Value	CEMS Response	
NMHC	400 ppm	0	7	27.4	26	267	264	.9997
CO_2	20%	0	0.05	9.0	9.14	15.0	14.8	0.9998
CO	250 ppm	0	1.0	34	37	88	83	0.998
O_2	25%	0	0.2	12.0	11.9	20.9	20.7	0.99999
NO_x	1000 ppm	0	2.0	280	262	500	475	0.9999

TABLE 3-40. ANALYTICAL BLANK AND SINGLE POINT RF CALIBRATION

Site: Peak Oil
Operator: JRG
Date/Time: 8-01-87/0650

		Analytical Blank			Single Point RF			
Monitor ID	Span Value	Reference Value	CEMS Response	Drift (%)	Reference Value	CEMS Response	Drift (%)	Response Factor (RF)
NMHC	400 ppm	0	6	1.5	27.4	22	-1.4	1.71
CO_2	20%	0	-0.08	0.08	15.2	15.1	-0.1	1.001
CO	250 ppm	0	1.5	0.6	34	37	-1.2	0.96
O_2	25%	0	0.5	0.5	12.0	12.2	0.2	1.03
NO_x	1000 ppm	0	-1.3	-0.13	344	350	0.6	0.98

TABLE 3-41. ANALYTICAL BLANK AND SINGLE POINT RF CALIBRATION

Site: Peak Oil
Operator: JRG
Date/Time: 8-02-87/0956

Monitor ID	Span Value	Analytical Blank			Single Point RF			Response Factor (RF)
		Reference Value	CEMS Response	Drift (%)	Reference Value	CEMS Response	Drift (%)	
NMHC	400 ppm	0	8	2.0	267	254	-3.3	1.09
CO_2	20%	0	0.013	0.013	12.0	12.4	0.4	0.97
CO	250 ppm	0	0.75	0.3	88	89	0.4	0.997
O_2	25%	0	0.05	0.05	5.1	5.2	0.1	0.99
NO_x	1000 ppm	0	0.81	0.08	280	310	3.0	0.91

TABLE 3-42. ANALYTICAL BLANK AND SINGLE POINT RF CALIBRATION

Site: Peak Oil
Operator: JRG
Date/Time: 8-03-87/0855

		Analytical Blank			Single Point RF			
Monitor ID	Span Value	Reference Value	CEMS Response	Drift (%)	Reference Value	CEMS Response	Drift (%)	Response Factor (RF)
NMHC	400 ppm	0	6	1.5	267	258	2.3	1.06
CO_2	20%	0	-0.1	-0.1	12.0	11.9	-0.3	1.00
CO	250 ppm	0	0.75	0.3	88	90	0.8	0.99
O_2	25%	0	0.18	0.18	20.9	21.3	0.4	0.99
NO_x	1000 ppm	0	2.0	0.2	500	440	-6.0	1.14

TABLE 3-43. ANALYTICAL BLANK AND SINGLE POINT RF CALIBRATION

Site: Peak Oil
Operator: JRG
Date/Time: 8-04-87/0744

Monitor ID	Span Value	Analytical Blank			Single Point RF			Response Factor (RF)
		Reference Value	CEMS Response	Drift (%)	Reference Value	CEMS Response	Drift (%)	
NMHC	400 ppm	0	6	1.5	267	267	0.3	1.02
CO_2	20%	0	0.02	0.02	15.0	14.9	-0.1	1.01
CO	250 ppm	0	1.0	0.4	34	38	1.6	0.92
O_2	25%	0	0.1	0.1	12.0	12.2	0.2	1.00
NO_x	1000 ppm	0	0.3	0.03	280	210	--	--

TABLE 3-44. ANALYTICAL BLANK AND SINGLE POINT DRIFT CHECK

Site: Peak Oil
Operator: JRG
Date/Time: 8-02-87/0135

		Analytical Blank			Single Point Drift Check		
Monitor ID	Span Value	Reference Value	CEMS Response	Drift (%)	Reference Value	CEMS Response	Drift (%)
NMHC	400 ppm	0	9	2.25	27	34	1.8
CO_2	20%	0	-0.06	-0.06	15.0	14.6	-0.4
CO	250 ppm	0	0.25	0.1	34	39	2.0
O_2	25%	0	0.18	0.18	12.0	12.3	0.3
NO_x	1000 ppm	0	1.0	0.1	280	300	2.0

TABLE 3-45. ANALYTICAL BLANK AND SINGLE POINT DRIFT CHECK

Site: Peak Oil
Operator: JRG
Date/Time: 8-02-87/2243

Monitor ID	Span Value	Analytical Blank			Single Point Drift Check		
		Reference Value	CEMS Response	Drift (%)	Reference Value	CEMS Response	Drift (%)
NMHC	400 ppm	0	6	1.5	267	254	-3.3
CO_2	20%	0	-0.06	-0.06	15.0	14.9	-0.1
CO	250 ppm	0	0.25	0.1	34	35	0.4
O_2	25%	0	0.025	0.025	12.0	12.1	0.1
NO_x	1000 ppm	0	2.0	0.2	280	276	0.4

TABLE 3-46. ANALYTICAL BLANK AND SINGLE POINT DRIFT CHECK

Site: Peak Oil
Operator: JRG
Date/Time: 8-03-87/1947

Monitor ID	Span Value	Analytical Blank			Single Point Drift Check		
		Reference Value	CEMS Response	Drift (%)	Reference Value	CEMS Response	Drift (%)
NMHC	400 ppm	0	7	1.8	267	242	-6.0
CO_2	20%	0	-0.04	-0.04	9.0	8.7	-0.3
CO	250 ppm	0	1.5	0.6	88	87	-0.4
O_2	25%	0	0.05	0.05	5.1	5.1	0.0
NO_x	1000 ppm	0	4.0	0.4	280	250	-3.0

TABLE 3-47. ANALYTICAL BLANK AND SINGLE POINT DRIFT CHECK

Site: Peak Oil
Operator: JRG
Date/Time: 8-05-87/0024

Monitor ID	Span Value	Analytical Blank			Single Point Drift Check		
		Reference Value	CEMS Response	Drift (%)	Reference Value	CEMS Response	Drift (%)
NMHC	400 ppm	0	6	1.5	267	248	-4.8
CO_2	20%	0	-0.14	-0.14	15.0	14.9	-0.1
CO	250 ppm	0	0.18	0.07	34	35	-0.4
O_2	25%	0	0.07	0.07	12.0	11.8	-0.2
NO_x	1000 ppm	0	2.0	0.2	280	255	-2.5

TABLE 3-48. PRECISION ESTIMATES FOR SOLIDS CHARACTERIZATION ANALYSES

	Field Duplicate Samples			Laboratory Duplicate Samples		
	1	2	RPD	1	2	RPD
Solid Waste Feed						
% Moisture	16.63	16.44	1.1	16.44	16.13	1.9
Carbon	7.61	9.79	25.0	9.79	10.67	8.6
Hydrogen	2.18	2.87	27.3	2.87	2.93	2.1
Oxygen	17.85	14.5	20.7	14.5	15.21	4.8
Nitrogen	0.06	0.05	18.2	0.05	0.07	33.3
Sulfur	2.53	2.49	1.6	2.49	2.49	0.0
Chlorine	0.1	0.14	33.3	0.14	0.1	33.3
Ash	69.77	70.16	0.6	70.16	68.53	2.4
HHV (Btu/lb)	2064	2043	1.0	2043	2358	14.3
Ash						
% Moisture	16.82	16.2	3.8	16.01	16.2	1.1
Carbon	3.53	2.66	28.1	2.06	2.26	9.2
Hydrogen	1.7	1.42	18.0	0.85	0.97	13.2
Oxygen	13.52	15.1	11.0	15.02	14.57	3.1
Nitrogen	0.02	0.03	40.0	0.02	0.02	0.0
Sulfur	2.29	2.12	7.8	2.33	2	15.3
Chlorine	0.26	0.1	89.0	0.1	0.11	9.5
Ash	78.68	78.67	0.01	79.72	80.07	0.4
Scrubber Solids						
% Moisture	46.72	46.67	0.1	46.67	44.26	5.2
Carbon	3.23	3.12	3.4	3.12	3.24	3.8
Hydrogen	0.34	0.26	26.9	0.26	0.21	21.2
Oxygen	0.5	0.5	0.0	0.5	0.5	0.0
Nitrogen	0.03	0.02	40.0	0.02	0.02	0.0
Sulfur	6.41	6.17	3.8	6.17	6.61	6.9
Chlorine	0.1	0.14	33.3	0.14	0.1	33.3
Ash	89.62	89.93	0.3	89.93	86.88	3.4

The following trip log documents the events that took place while the Radian field crew was on the Peak Oil site. The log chronicles the testing times, climate interferences, process upsets, and general proceedings involving the Radian field crew.

Thursday 7/30/87

Radian crew arrived on site at 8:30 a.m. Mike Fuchs and Vince Lara flew in from Austin at 11:30 a.m.

Equipment set-up took place in the morning.

1-hour lunch between 12:30 and 1:30 p.m.

Radian/Thunderstorm delay between 2:30 and 4:00 p.m.

Finished set-up at 9:00 p.m.

Friday 7/31/87

Radian arrived at site at 7:00 a.m.

Started ambient PCB samplers at 10:00 a.m.

Set up to do SASS/PCB run.

Plant not at correct conditions.

Plant ready for testing at 11:30 a.m.

Having leak check problems with SASS.

Started SASS at 1:00 p.m.

Started chrome and VOST runs at 2:00 p.m.

Thunderstorm hit area at 4:30 p.m.

Storm stopped feed to unit at 5:00 p.m.

Completed 1 chrome, 4 VOST, and 1/2 SASS runs before storm hit.

Radian crew took short lunch during storm.

Tom Robinson of Shirco indicated that it would be 1 hour until testing could resume, he said this at 5:45 p.m.

Enviresponse/EPA decided to scrub first day of tests and start anew tomorrow.

Prepped for tomorrow and left site at 9:00 p.m.

Saturday 8/1/87

Radian crew arrived at site at 6:00 a.m.

Set up to do SASS/PCB run.

SASS/PCB run started at 10:00 a.m.

Started ambient PCB samplers at 11:00 a.m.

Having trouble keeping XAD-2 temperature below 68°F according to protocol.

Burt Blackburn on site as auditor, questioned XAD-2 temperature.

Radian decided to scrap run.

New SASS/PCB run started at 2:30 p.m. with better cooling unit and lower flowrate to control temperature better.

Method 5 run started at 8:30 a.m.

Completed Method 5 run at 10:23 a.m.

Thunderstorm hit around 3:30 p.m.

Delayed testing until 5:00 p.m.

Radian crew took a 1-hour lunch during delay.

Chrome run started at 4:50 p.m.

Chrome run completed at 7:25 p.m.

SASS/PCB run completed at 7:20 p.m.

SASS/Dioxin run started at 9:21 p.m.

SASS/Dioxin run completed at 1:30 a.m.

VOST runs started at 5:10 p.m.

VOST runs completed at 10:04 p.m.

Radian crew left site at 2:00 a.m.

Sunday 8/2/87

Radian crew arrived on site at 6:30 a.m.

SASS/PCB run started at 11:00 a.m.

Started ambient PCB samplers at 11:15 a.m.

SASS/PCB run completed at 4:15 a.m.

SASS/Dioxin run started at 6:00 p.m.

SASS/Dioxin run completed at 10:11 p.m.

Chrome run started at 12:02 p.m.

Chrome run completed at 2:42 p.m.

VOST runs started at 2:10 p.m.

VOST runs completed at 6:05 p.m.

Method 5 run completed at 10:11 p.m.

Method 5 run was completed one minute shorter than planned due to a plant upset.

Shirco requested that Method 5 run be terminated.

Rain fell throughout the day, making sampling difficult although not delaying the process or sampling.

Burt Blackburn had minor comments on Radian's testing in his audit review.

Film crew was on site all day making it difficult to naturally proceed with the sampling.

No lunch break for Radian crew today.

Testing completed; Radian crew left site at 11:30 p.m.

Monday 8/3/87

Radian crew arrived on site at 7:00 p.m.

Duplicate testing to begin today.

Monday 8/3/87 (continued)

Started duplicate SASS/PCB runs at 10:15 a.m.

Started ambient PCB samplers at 10:30 a.m.

Completed duplicate SASS/PCB runs at 3:50 p.m.

Started duplicate chrome runs at 5:13 p.m.

Completed duplicate chrome runs at 7:45 p.m.

Intermittent rain showers throughout day did not hinder process or sampling.

Radian crew did not take lunch break.

Completed testing, left site at 900 p.m.

Tuesday 8/4/87

Radian crew arrived on site at 7:00 a.m.

Started duplicate SASS/Dioxin runs at 9:30 a.m.

Started ambient PCB samplers at 10:00 a.m.

Completed duplicate SASS/Dioxin runs at 2:45 p.m.

Started duplicate Method 5 runs at 3:50 p.m.

Completed duplicate Method 5 runs at 5:46 p.m.

Started duplicate VOST runs at 8:10 p.m.

Completed duplicate VOST runs at 12:20 a.m.

No rain today, everything went smoothly.

Deprepped equipment and left site at 12:30 a.m.

Wednesday 8/5/87

Radian crew arrived at site at 9:00 a.m.

Composited and split remaining liquid and solid samples for analyses.

Broke down equipment and packed up.

Left site at 8:00 p.m.

APPENDIX C

QUALITY ASSURANCE PROJECT PLAN/TEST PLAN

Included herein is a copy of the approved Quality Assurance Project Plan/Test Plan as prepared by Radian Corporation and dated August 10, 1987.

QUALITY ASSURANCE PROJECT PLAN/TEST PLAN

Haztech/Shirco Incinerator at
Peak Oil Site in Brandon, Florida

10 August 1987

Prepared for:

Mr. Sy Rosenthal
Enviresponse, Inc.
GSA Raritan Depot
Woodbridge Avenue
Building 209, Bay F
Edison, New Jersey 08837

Prepared by:

Radian Corporation
8501 Mo-Pac Boulevard
P.O. Box 9948
Austin, TX 78766-0948

6.6.1

QUALITY ASSURANCE PROJECT PLAN APPROVAL FORM
for
HWERL Contracts/IAGs/Cooperative Agreements/In-house Projects

Lab Workplan No: 87134Y

Task Start Date:
(for measurement, data gathering, and/or data generation activities)

Project Category: II

QA ID No: S-183-E

Date QAPP Received: 7-14-87

Task Title: Haztech/Shirco Incinerator at Peak Oil Site in Brandon, Florida

Technical Project Officer: Howard Wall, TDB, ATD

Contractor: Radian (subcontractor to Enviresponse)

APPROVALS:

Enviresponse — SEYMOUR ROSENTHAL Contractor Project/Task Manager	Signature	7-14-87 Date
Enviresponse - J. BORRIS Contractor QA Manager	J. Borris Signature	7-14-87 Date
Radian - Michael Fuchs Affiliate Task Manager*	Michael Fuchs Signature	7-13-87 Date
TECH. PROJ. MGR. Other (as appropriate)	Howard Wall Signature	7/14/87 Date
PROJECT MGR. HWERL Technical Project Officer	Howard Wall Signature	7/14/87 Date
R A Olexsey HWERL Branch or Staff Chief**	Robt A Olexsey Signature	7/16/87 Date
GUY SIMES HWERL Quality Assurance Officer	Guy Simes Signature	7-15-87 Date

* Approval signature is required for any ancillary sampling, analytical, or data gathering support provided by a subcontractor or HWERL principal investigator.

** Approval signature from the HWERL Branch or Staff Chief is required for Category I, II, and III extramural projects and for all in-house projects.

HWERL (QAPP AF)
(October 1986)

CONTENTS

Section		Pages	Revision	Date
1	Project Description	4	0	4-17-87
2	Project Organization and Responsibility	3	2	8-10-87
3	Data Quality Objectives	4	2	8-10-87
4	Sampling Procedures	51	2	8-10-87
5	Laboratory Procedures/Calibrations/ Quality Control	51	2	8-10-87
6	Data Reduction, Validation, and Reporting	8	2	8-10-87
7	Internal Quality Control Checks	9	2	8-10-87
8	Performance and System Audits	1	0	4-17-87
9	Data Quality Indicators	4	2	8-10-87
10	Corrective Actions	2	0	4-17-87
11	Quality Assurance Reporting	1	0	4-17-87
12	Project Safety	3	0	4-17-87
	Appendix A			

LIST OF FIGURES

Title	Figure No.	Section	Page
Haztech/Shirco Demonstration Project Schedule	1-1	1	3 of 4
Shirco Incinerator Demonstration Test Program Organization	2-1	2	2 of 3
Schematic of the Haztech/Shirco Incinerator Indicating Sampling Locations	4-1	4	3 of 51
Haztech/Shirco Incinerator Process Data Recording Sheet	4-2	4	15 of 51
Schematic of the EPA Method 5 Sampling Train for Particulate Matter and HCl	4-3	4	17 of 51
Source Assessment Sampling System Train	4-4	4	20 of 51
Source Sampling Data Sheet	4-5	4	23 of 51
Schematic Diagram of VOST Sampling Train	4-6	4	25 of 51
VOST Source Sampling Data Sheet	4-7	4	26 of 51
Inside-Inside VOST Cartridge	4-8	4	28 of 51
Example of the Pitot Inspection Sheet	4-9	4	37 of 51
Nozzle Calibration Data Sheet	4-10	4	38 of 51
Differential Pressure Gauge Calibration Form	4-11	4	39 of 51
Temperature Sensor Calibration Form	4-12	4	41 of 51
Dry Gas Meter Calibration System	4-13	4	42 of 51
Dry Gas Meter Calibration Form	4-14	4	44 of 51
Dry Gas Meter Post-Test Calibration Check Form	4-15	4	45 of 51
Example of Radian Master Logbook Format	4-16	4	47 of 51
Example of Radian Sample Label	4-17	4	48 of 51
Example of Radian Chain-of-Custody Seal	4-18	4	49 of 51

LIST OF FIGURES

Title	Figure No.	Section	Page
Example of Radian Chain-of-Custody Report Form	4-19	4	50 of 51
Overall Data Reduction, Validation, and Reporting Flow Scheme for the Shirco Incinerator Unit Trial Burn at Brandon, Florida	6-1	6	2 of 8
Corrective Action Flow Scheme	10-1	10	2 of 2

LIST OF TABLES

Title	Table No.	Section	Page
HAZTECH/SHIRCO INCINERATOR DEMONSTRATION TEST MILESTONES AND PLANNED DATES	1-1	1	4 of 4
SUMMARY OF ESTIMATED PRECISIONS, ACCURACY, AND DATA CAPTURE OBJECTIVES	3-1	3	2 of 4
SUMMARY OF SAMPLING AND ANALYTICAL PLAN FOR THE PEAK OIL SITE, BRANDON, FLORIDA	4-1	4	9 of 51
CALIBRATION FREQUENCY OF FIELD SAMPLING EQUIPMENT	4-2	4	35 of 51
SUMMARY OF TEMPERATURE CALIBRATION REQUIREMENTS	4-3	4	43 of 51
SUMMARY OF ANALYTICAL QUALITY CONTROL CHECKS, FREQUENCIES, ACCEPTABLE CRITERIA, AND CORRECTIVE ACTIONS	5-1	5	4 of 51
PRESERVATION REQUIREMENTS AND HOLDING TIMES FOR SAMPLES	5-2	5	5 of 51
GC/MS ANALYTICAL CONSIDERATIONS FOR VOST TENAX TRAPS	5-3	5	8 of 51
COMPOUNDS FOR METHOD 8240 ANALYSIS	5-4	5	10 of 51
BFB KEY ION ABUNDANCE CRITERIA	5-5	5	12 of 51
DFTPP KEY IONS AND ION ABUNDANCE CRITERIA	5-6	5	17 of 51
COMPOUNDS FOR METHOD 8270 ANALYSIS	5-7	5	18 of 51
RECOMMENDED GC OPERATING CONDITIONS FOR PCB ANALYSIS	5-8	5	25 of 51
METHODS AND DETECTION LIMITS FOR METALS ANALYSIS	5-9	5	32 of 51
ANALYTICAL METHODS FOR TOXICITY CHARACTERISTIC METALS	5-10	5	38 of 51
PROPOSED TOXICITY CHARACTERISTIC CONTAMINANTS AND REGULATORY LEVELS	5-11	5	39 of 51

LIST OF TABLES

Title	Table No.	Section	Page
STANDARDS FOR CONTINUOUS MONITORS	5-12	5	49 of 51
SUMMARY OF CONTINUOUS MONITOR CALIBRATION REQUIREMENTS	5-13	5	51 of 51
SUMMARY OF DATA REDUCTION, REVIEW, AND VALIDATION AND REPORTING RESPONSIBILITIES	6-1	6	8 of 8

1.0 PROJECT DESCRIPTION

Enviresponse, Inc is under contract to the United States Environmental Protection Agency (USEPA) to provide technical and engineering services in support of various USEPA hazardous waste treatment demonstration programs. One such demonstration program includes testing of a transportable infrared incineration system being operated by Haztech, Inc. The incinerator is being used to destroy PCBs (polychlorinated biphenyls) in an abandoned landfill at the Peak Oil site in Brandon, Florida.

The incinerator system includes a Shirco infrared primary combustor, a secondary combustion chamber, and an air pollution control system. The system is transportable and is a candidate technology for the destruction of contaminated materials as part of remedial actions at contaminated sites.

During the test program at Peak Oil, the unit will be operated at a single set of conditions, previously established to optimize destruction of organic contaminates in the waste. Results of the incineration tests will provide the USEPA with information necessary in the evaluation of the Haztech/Shirco transportable infrared incinerator as a technology suitable for the destruction of hazardous constituents in contaminated materials.

Enviresponse, Inc. is serving as the procurement agent of the USEPA during this program. Radian is under contract to Enviresponse, Inc. to provide the sampling and analytical support services necessary to gather the data required to evaluate the suitability of the Haztech/Shirco system to destroy solid hazardous materials.

The monitoring program will be designed and executed with emphasis on completeness and data quality. A comprehensive quality assurance (QA) and quality control (QC) program will be an integral part of the overall test program. The goal of the QA/QC effort will be to ensure that the data collected are of known precision and accuracy and that they are complete, representative, and comparable.

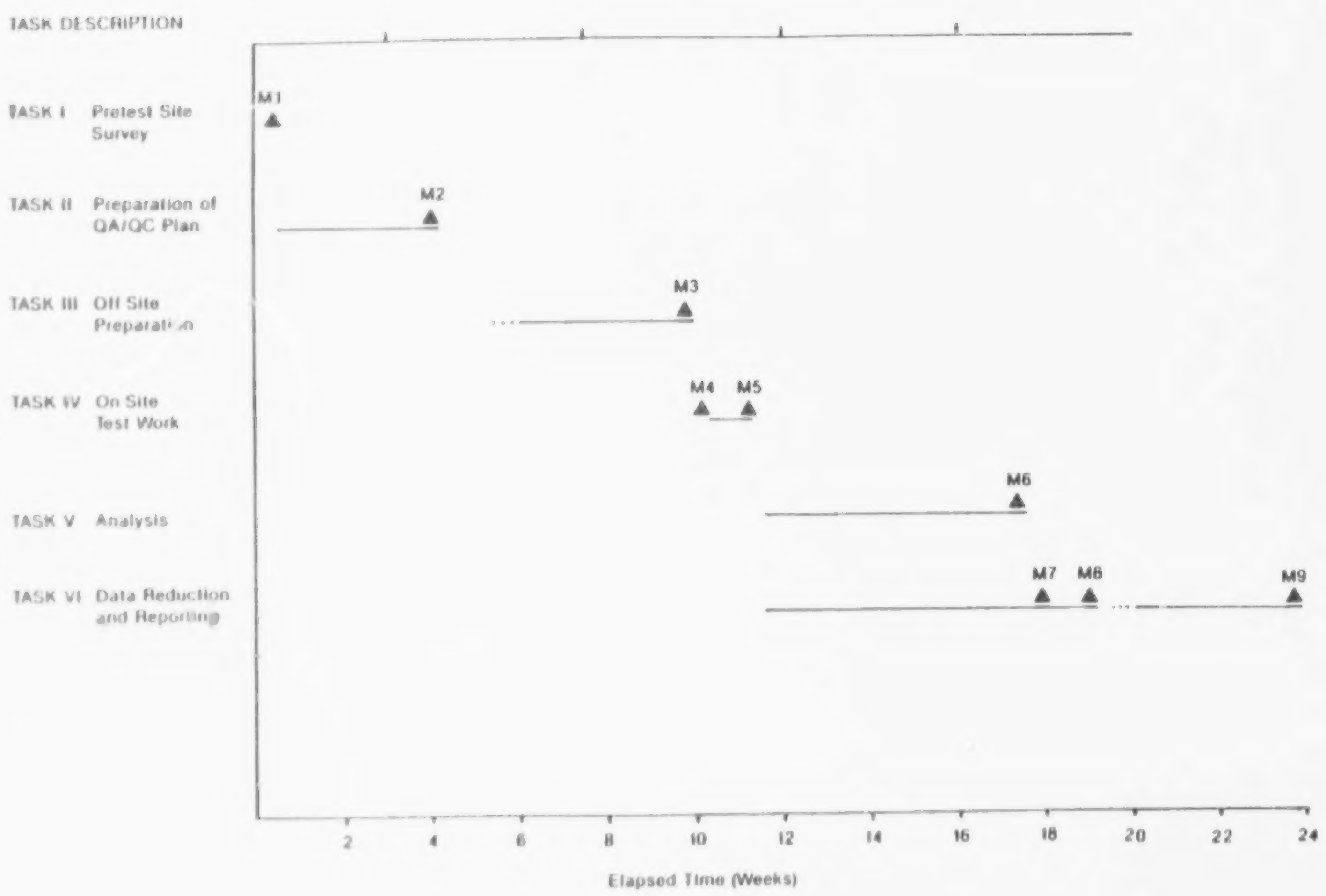


Figure 1-1. Haztech/Shirco Demonstration Project Schedule

Figure 1-1 presents the overall program schedule and illustrates the sequence and duration of each task. Program milestones are listed in Table 1-1.

1.0 PROJECT DESCRIPTION

Enviresponse, Inc is under contract to the United States Environmental Protection Agency (USEPA) to provide technical and engineering services in support of various USEPA hazardous waste treatment demonstration programs. One such demonstration program includes testing of a transportable infrared incineration system being operated by Haztech, Inc. The incinerator is being used to destroy PCBs (polychlorinated biphenyls) in an abandoned landfill at the Peak Oil site in Brandon, Florida.

The incinerator system includes a Shirco infrared primary combustor, a secondary combustion chamber, and an air pollution control system. The system is transportable and is a candidate technology for the destruction of contaminated materials as part of remedial actions at contaminated sites.

During the test program at Peak Oil, the unit will be operated at a single set of conditions, previously established to optimize destruction of organic contaminates in the waste. Results of the incineration tests will provide the USEPA with information necessary in the evaluation of the Haztech/Shirco transportable infrared incinerator as a technology suitable for the destruction of hazardous constituents in contaminated materials.

Enviresponse, Inc. is serving as the procurement agent of the USEPA during this program. Radian is under contract to Enviresponse, Inc. to provide the sampling and analytical support services necessary to gather the data required to evaluate the suitability of the Haztech/Shirco system to destroy solid hazardous materials.

The monitoring program will be designed and executed with emphasis on completeness and data quality. A comprehensive quality assurance (QA) and quality control (QC) program will be an integral part of the overall test program. The goal of the QA/QC effort will be to ensure that the data collected are of known precision and accuracy and that they are complete, representative, and comparable.

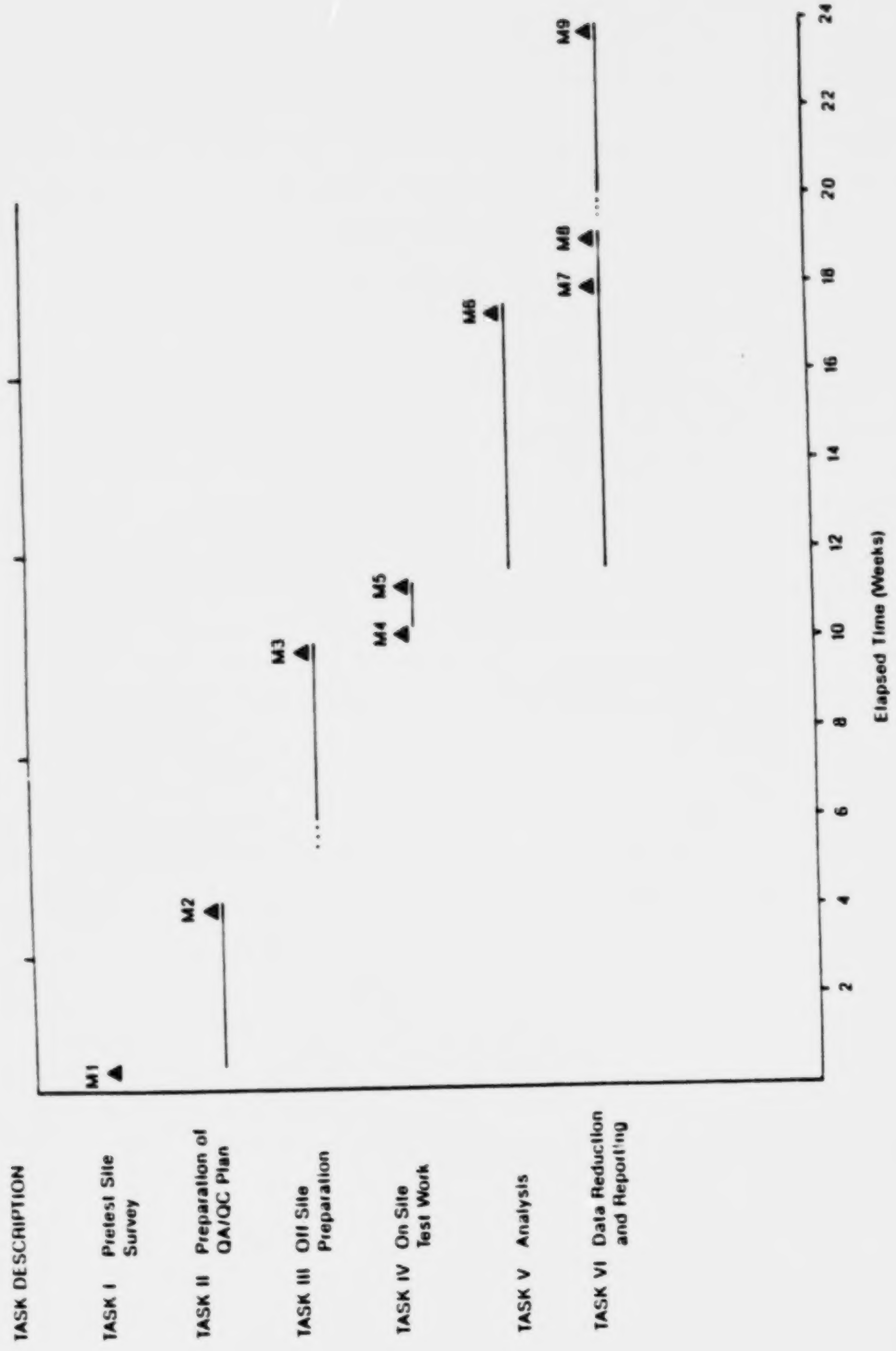


Figure 1-1. Haztech/Shirco Demonstration Project Schedule

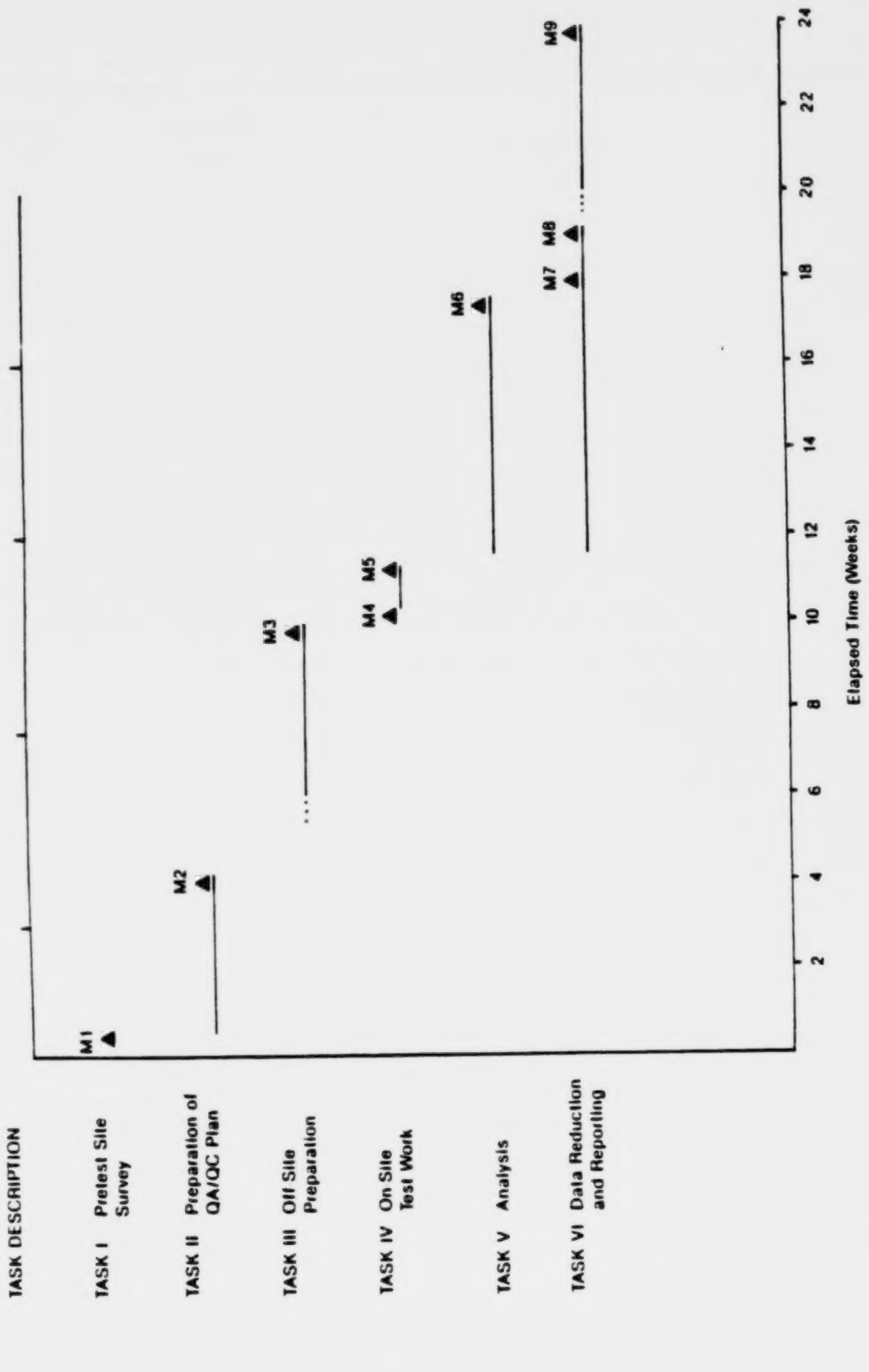


Figure 1-1. Haztech/Shirco Demonstration Project Schedule

TABLE 1-1. HAZTECH/SHIRCO INCINERATOR DEMONSTRATION TEST MILESTONES AND PLANNED DATES

Milestone	Description	Planned Date	Completed Date
M1	Perform Pretest Site Survey	3/12/87	
M2	Submit QA/QC Plan to Enviresponse	4/17/87	
M3	Complete Field Test Preparations	Day 1 (TBD[1])	
M4	Complete CEMS Set-up and Check-out	Day 4	
M5	Complete Test Program	Day 8	
M6	Complete Sample Analysis	Day 54	
M7	Complete Data Reduction	Day 59	
M8	Submit Draft Final Report to Enviresponse	Day 68 (To be Submitted 60 Days After On-site Sampling Effort is Complete.)	
M9	Submit Final Report to Enviresponse	30 Days After Receipt of Comments	

[1] To be Determined

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The project organization for the Haztech/Shirco incinerator sampling program is presented in Figure 2-1. The quality assurance (QA) and quality control (QC) functions have been organized to allow independent review of project activities, while providing on-site QC coordination by the person most knowledgeable of the sampling/analysis activities.

The objectives of the quality control efforts for this program are to assess and to document the precision, accuracy, and adequacy of the process and emission data developed during sampling and analysis.

The QA Coordinator for this project is Mr. D.L. Lewis. While Mr. Lewis coordinates the development and execution of the QA activities for the field testing effort, he will also be responsible for reviewing the QA Project Plan, evaluating the internal QC program, and documenting the results of all QA/QC activities.

As task leader for the sampling effort, Mr. M.J. Krall will be responsible for implementing the project-specific system of quality control activities. He will schedule all on-site QC activities, establish on-site sampling/analysis protocols, and coordinate record keeping and data review and validation.

The analytical task leader, Mr. D.E. Wagoner, will be responsible for the off-site analytical effort. His responsibilities include obtaining valid analytical data for all project samples and adhering to quality control requirements specified in the analytical methods. An outside laboratory has been subcontracted to perform some of the sample analysis during this project.

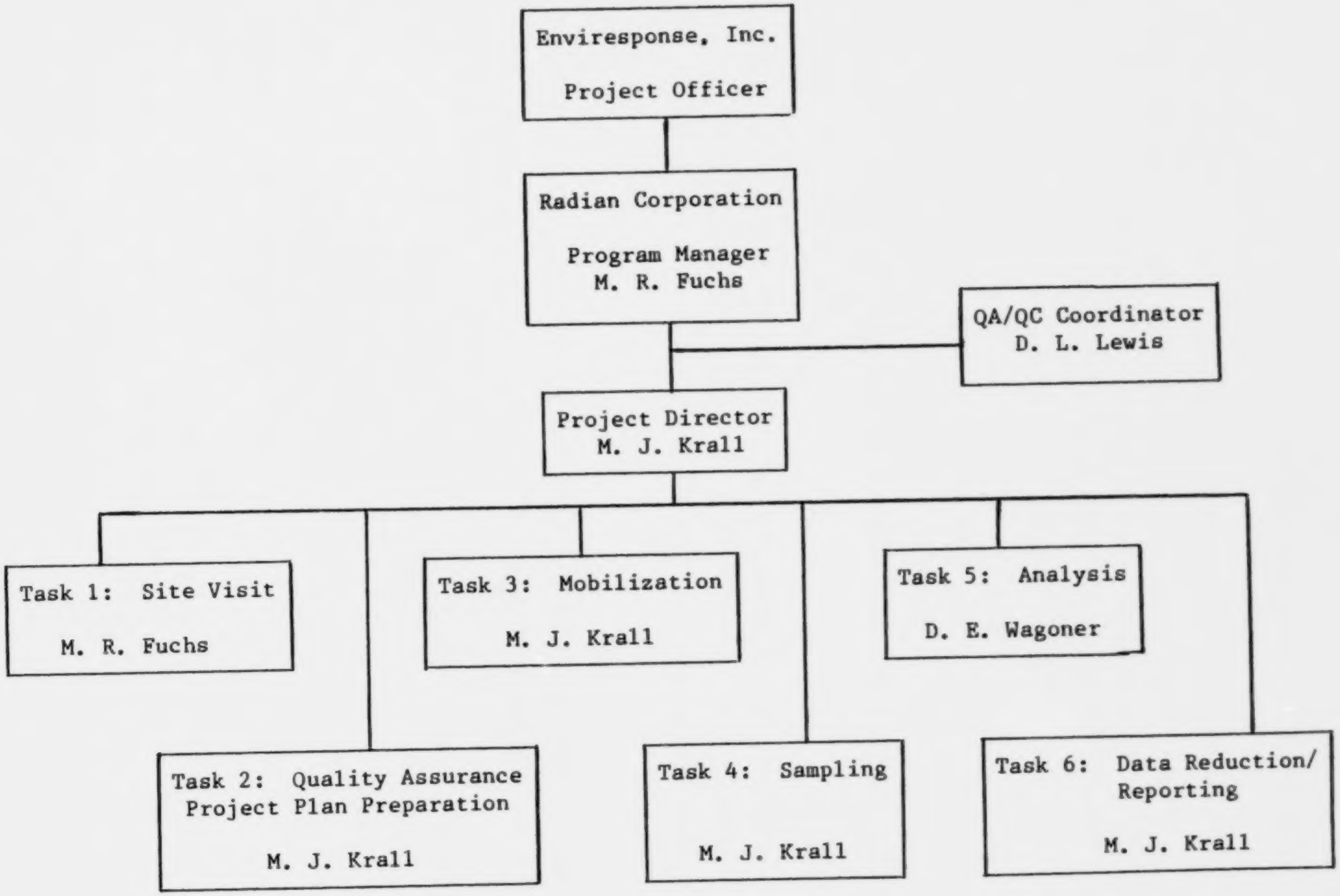

Enviresponse, Inc.
Project Officer
Radian Corporation
Program Manager
M. R. Fuchs
QA/QC Coordinator
D. L. Lewis
Project Director
M. J. Krall
Task 1: Site Visit
M. R. Fuchs
Task 2: Quality Assurance Project Plan Preparation
M. J. Krall
Task 3: Mobilization
M. J. Krall
Task 4: Sampling
M. J. Krall
Task 5: Analysis
D. E. Wagoner
Task 6: Data Reduction/ Reporting
M. J. Krall

Figure 2-1. Shirco Incinerator Demonstration Test Program Organization

Huffman Laboratories, Inc. (Golden, Colorado) will perform chlorine analysis and ash content of the solid waste feed, furnace ash, scrubber solids, and ultimate analysis and higher heating value of the solid waste feed. The remaining analyses will be performed by Radian Corporation in Austin, Texas, and Research Triangle Park, North Carolina.

Dale Raines of Huffman Laboratories, Inc. will coordinate the QA/QC activities during the sample analyses there. His duties will include reviewing all results of sample analyses, calibrations, blanks, duplicate analyses, and analytical system performance checks.

The Project Director, Mr. M.J. Krall, is ultimately responsible for the overall technical effort. This responsibility includes the timely, cost-effective execution of all project activities. He will also coordinate preparation of the final report.

The Program Manager, Mr. M.R. Fuchs, has ultimate responsibility for completing this program in accordance with the program objectives and within schedule and budget constraints.

3.0 DATA QUALITY OBJECTIVES

The objectives of the quality assurance plan for this project are two-fold. First, the plan provides the mechanism for ongoing control and evaluation of measurement data quality throughout the course of the project. Second, audit results and quality control data will ultimately be used to define data quality for the various measurement parameters in terms of both precision and accuracy. These data quality estimates will, in turn, be used to define the magnitude of the uncertainty associated with the measured emission concentration values.

Data quality objectives for the measurement parameters associated with this project are presented in Table 3-1. Precision estimates presented in the table represent variability for replicate measurements of the same parameter, expressed in terms of coefficient of variation (relative standard deviation). Accuracy values include components of both random error and bias, expressed as a percentage of the true value. A full discussion of the quantitative assessment of the measurement system data, particularly precision and accuracy, can be found in Section 9.0. The measurement parameters associated with the accuracy of GC/MS analyses, specified in Note C of Table 3-1, refer to the GC/MS analyses of target analytes in matrix spiked samples. [The extraction recovery efficiency will be determined for sample spikes of target parameters.] The acceptance criterion for the analysis of these sample spikes will be ±50% of the theoretical value, as specified in Table 3-1. All samples will be spiked for extraction recovery efficiency determination. Data capture represents the percentage of valid data collected from the total number of tests conducted.

No data quality objectives for total dissolved solids, total suspended solids, ash, ultimate analysis, higher heating value, and pH are presented because these are system parameters to be monitored and are not critical measurements.

TABLE 3-1. SUMMARY OF ESTIMATED PRECISIONS, ACCURACY, AND DATA CAPTURE OBJECTIVES

Parameter (Method)	Precision	Accuracy	Data Capture[a]	
PCDD/PCDF (Flue Gas - SASS and Solid/Liquid)	50%[b]	± 50%[c]	90%	
PCBs (Flue Gas - SASS, Ambient and Solid/Liquid)	50%[b]	± 50%[c]	90%	*
Volatile Organics (Flue Gas - VOST and Solid/Liquid)	30%[b]	± 50%[c]	90%	
Semi-Volatile Organics (Flue Gas - SASS and Solid/Liquid)	30%[b]	± 50%[c]	90%	
Particulate Matter (Flue Gas - Method 5)	11%[d]	± 10%[d]	90%	
HCl (Flue Gas - Caustic Impinger)	10%[b]	±10%[c]	90%	
Flue Gas - Velocity/Volumetric Flow Rate (Methods 1 and 2)	6%[d]	± 10%[d]	95%	
Flue Gas - Fixed Gases/Molecular Weight (Method 3)	10%[f]	± 20%[e]	90%	
Flue Gas - Moisture (Method 4)	20%[d]	± 10%[d]	90%	
Flue Gas O_2 (Continuous Emission Monitoring System)	20%[f]	± 20%[e]	90%	
Flue Gas NO_x (Continuous Emission Monitoring System)	20%[f]	± 20%[e]	90%	*
Flue Gas CO (Continuous Emission Monitoring System)	20%[f]	± 20%[e]	90%	
Flue Gas CO_2 (Continuous Emission Monitoring System)	20%[f]	± 20%[e]	90%	
Flue Gas THC (Continuous Emission Monitoring System)	20%[f]	± 25%[e]	90%	

Continued ...

TABLE 3-1. (Continued)

Parameter (Method)	Precision	Accuracy	Data Capture[a]
Chlorine (Solid/Liquid)	20%[b]	± 10%[c]	90%
EP Toxicity Metals (Solid/Liquid)	20%[b]	± 25%[e]	90%
TCLP (Solid/Liquid)	30%[b]	± 50%	90%
Metals (Flue Gas and Solid/Liquid)	20%[b]	± 15%[c]	90%

[a] Valid data percentage of total tests conducted

[b] Coefficient of variation for duplicate analyses, where:

$$CV = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100\%$$

[c] Relative error (%) based on recovery of matrix spike analytes native to each analytical method matrix, where:

$$\% = \frac{\text{Measured Value} - \text{Spiked Value}}{\text{Spiked Value}} \times 100\%$$

[d] Precision and accuracy estimate based on results of EPA collaborative tests

[e] Relative error (%) for audit analyses, where:

$$\% = \frac{\text{Measured Value} - \text{Theoretical Value}}{\text{Theoretical Value}} \times 100\%$$

[f] Coefficient of variation (CV) for daily analyses of control sample prior to and after daily testing, where:

$$CV = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100\%$$

The QA/QC program focus will be upon controlling measurement error within these estimated limits of measurement uncertainty. It should be noted that these are estimates which are, in most cases, described in the methods and represent the range of results which can be expected from these methods based on actual field sampling results and laboratory-based QA/QC studies. It is therefore reasonable to expect that the measurement errors associated with this project will be within the estimates shown on Table 3-1. In the event that ongoing QA/QC procedures reveal that a measurement's error has exceeded these estimated limits, the source of the excessive error will be immediately identified and corrective action taken, as described in Section 10.

4.0 SAMPLING PROGRAM

Included in this section are descriptions of the test program, sampling locations, and sampling procedures, and analytical procedures that will be used during the Haztech/Shirco incineration demonstration test.

4.1 Process Description

Solid waste processed at the Peak Oil site will be incinerated in a transportable infrared incinerator, designed and manufactured by Shirco Infrared Systems, Inc. of Dallas, Texas and owned and operated by Haztech, Inc. of Decatur, Georgia. The system consists of a waste preparation system, feed metering system, infrared primary chamber, supplemental propane-fired secondary chamber, venturi scrubber, data collection and control systems, and heating element power centers, all mounted on transportable trailers.

4.1.1 General Process Description

Solid waste feed material is processed by waste preparation equipment designed to reduce the waste to particle sizes that can be handled by the incinerator. After transfer from the waste preparation equipment, the solid waste feed is weighed. The waste feed material is then fed to a hopper mounted over the furnace conveyor belt. A feed chute on the hopper distributes the material across the width of the conveyor belt. The feed hopper screw rate and the conveyor belt speed rate are used to control the feed rate and bed depth.

The incinerator conveyor moves the solid waste feed material through the primary heating unit where it is subjected to combustion temperatures by infrared heating elements. Rotary mixers agitate the material to ensure proper even waste composition and complete combustion. When the ash reaches the discharge end of the incinerator, it is sprayed with water. The wet ash is then discharged by a screw auger to an ash hopper.

The combustion air to the incinerator is supplied through a series of overfire air ports located at various locations along the incinerator chamber. The gas flow in the incinerator is concurrent to the conveyed waste feed material.

Exhaust gas exits the primary incinerating unit into a secondary incinerator where propane-fired burners combust any residual organics present in the exhaust gas. The secondary burners are set to burn at a predetermined temperature. The air to the secondary burners is supplied by lateral air ports along the length of the secondary incinerator. Exhaust gas from the secondary incinerating unit is then quenched by a water-fed venturi scrubber to remove particulate matter and acid gases and then transferred to the exhaust stack by an induced draft fan where the gas is discharged to atmosphere.

4.1.2 Detailed Description of the Incinerating Unit

A detailed description of the incinerating unit is presented below. A layout diagram illustrating the various subunits of the incinerator and the sampling locations is in Figure 4-1. The ambient air sampling locations will not be determined until sampling commences. *
*

4.1.2.1 Incinerating Unit Description

The transportable incineration unit consists of the following major mechanical subunits and components:

- Waste Preparation Unit,
- Weigh and Feed Hoppers,
- Primary Incineration Chamber,
- Secondary Combustion Chamber,
- Emergency Bypass Stack,
- Venturi Scrubber,
- Exhaust System, and
- Control System Van.

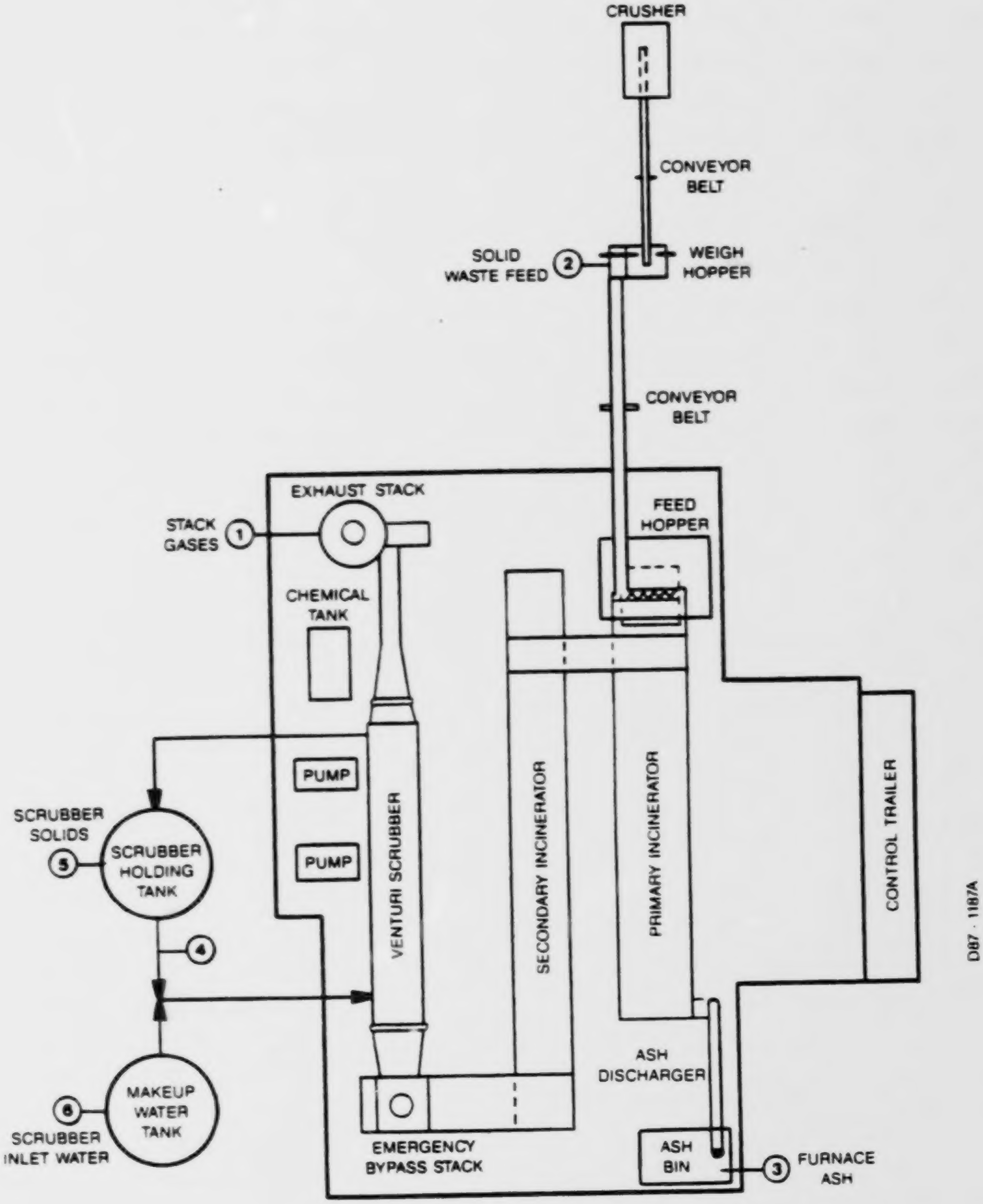

CRUSHER
CONVEYOR BELT
SOLID WASTE FEED
②
WEIGH HOPPER
CONVEYOR BELT
EXHAUST STACK
STACK GASES
①
FEED HOPPER
CHEMICAL TANK
PUMP
PUMP
SCRUBBER SOLIDS
⑤
SCRUBBER HOLDING TANK
④
VENTURI SCRUBBER
SECONDARY INCINERATOR
PRIMARY INCINERATOR
CONTROL TRAILER
D87 · 1187A
MAKEUP WATER TANK
⑥
SCRUBBER INLET WATER
ASH DISCHARGER
EMERGENCY BYPASS STACK
ASH BIN
③
FURNACE ASH

Figure 4-1. Schematic of the Haztech/Shirco Incinerator Indicating Sampling Locations.

These subunits have been transported individually to the Peak Oil site and have been assembled into one unit. Periodic inspections and maintenance of all mechanical units are accomplished on site and during installation and disassembly. A description of each subunit follows.

4.1.2.2 Solid Waste Feed Preparation Unit

A crusher will be used for solid waste processing at the Peak Oil site. The crusher consists of a large hopper covered with a 4 in. x 4 in. grid screen situated at a deep angle, through which all solid waste is loaded. Any wastes which are larger than 4 in. x 4 in. will drop off the screen and be collected in a metal container beneath the crusher hopper. The waste falling through the screen enters a single-roll crusher which will further reduce all particles to a maximum 1 in. x 1 in. size.

Waste will move via a conveyor belt from the crusher to the weigh hopper.

4.1.2.3 Weigh and Feed Hoppers

Waste will be conveyed into the weigh hopper from the crusher until a predetermined weight is attained. At that time, waste feed to the weigh hopper will be stopped and waste will be conveyed from the weigh hopper to the feed hopper via a conveyor belt. The feed hopper consists of six 9-inch screws which will feed the waste in consistent depths across the width of the incinerator belt.

4.1.2.4 Primary Incineration Chamber

The Primary Incineration Chamber is comprised of six powered, one feed, and one discharge module constructed of mild carbon steel. These modules are bolted together and mounted on a skid which is attached for transportation.

Each module is insulated with a 1-inch thick layer of ceramic fiber blanket and a 3-mil stainless steel vapor barrier next to the steel shell with additional fiber insulation added as the innermost temperature barrier. The interior steel surface of each module is sprayed with stilastic before the insulation is installed to further protect the shell from corrosive volatiles which might penetrate the insulation at process temperatures. The exterior shell is primed and painted with high temperature resistant paint to provide a durable protective surface.

The modules are heated by transversely mounted silicon carbide resistance heating elements which are insulated from the steel shell with ceramic sleeves.

The feed material enters the Primary Incineration Chamber through the top of the Feed Module for processing. It drops onto a metal alloy belt which transports the material through the chamber. The belt is pulled through the chamber by a chain driven roller system mounted in the feed module.

Chain driven mixers in the modules stir the feed material periodically and increase process efficiency. The mixers are rollers with high temperature alloy "fingers" attached which slowly rake through the material layer on the belt as it moves through the fired zones in the incinerating chamber.

The processed feed material drops off the end of the belt in the discharge module where it is quenched with water sprays prior to being discharged by the screw conveyor. The floor of the primary chamber consists of hoppers and screw conveyors, to collect and remove residual ash (which sifts through the belt) from the system. Each hopper has a small vibrator attached to the bottom to assist in the removal of ash into the center mounted collector screw.

The combustion air for the Primary Incineration Chamber is provided by a blower mounted on the skid underneath the last module at the discharge end. The combustion air is carried by ductwork up both sides of the chamber, along the top edges of the chamber, and into the chamber at strategically located ports. Manually operated gate valves are used to control the flow of combustion air into the primary chamber. The combustion air flow within the chamber itself is from the discharge end toward the feed module which is opposite to feed material movement (counter-current flow).

Exhaust gas from the Primary Incineration Chamber exits through the top of the chamber just prior to reaching the feed material inlet chute. The exhaust gas is directed to the adjacent Secondary Combustion Chamber by an insulated crossover duct.

4.1.2.5 Secondary Combustion Chamber

The Secondary Combustion Chamber is constructed and insulated in a manner very similar to the Primary Incineration Chamber. Its purpose is to thermally destroy the combustible off-gas compounds carried in the exhaust gas from the Primary Incineration Chamber. The chamber is fired by four propane burners mounted on the forward end of the chamber.

Combustion air is provided by a blower on the inlet end of the chamber. The four burner blocks also have a combustion air blower and ductwork for controlling burner flame patterns.

The Primary Incineration Chamber exhaust gas enters the Secondary Combustion Chamber just above the burner flame patterns. The flow turns 90° and passes through a series of rods which increases combustion efficiency by creating turbulence. The waste gas then continues to the downstream end of the chamber where it exits through the top of the chamber into a crossover duct leading to the base of the emergency by-pass stack.

4.1.2.6 Emergency Bypass Stack

An Emergency Bypass Stack is mounted in the system between the secondary chamber and the venturi scrubber. It is designed to divert the high temperature gases during a process upset condition and is not in operation under normal operating conditions.

The Emergency Bypass Stack is a vertically mounted, rectangular cross-section carbon steel shell which is insulated in the same manner as the Primary and Secondary Chambers. It is sealed at the top with the counter-weighted doors which would be opened by a compressed air system during an upset condition.

4.1.2.7 Venturi Scrubber

The normal flow of exhaust gas from the Secondary Combustion Chamber will be through the base of the Emergency Bypass Stack where the waste gas is split into two separate streams prior to entering the venturi scrubber section. Both streams exit the Emergency Bypass Stack into tubes where the hot waste gas is cooled with quench water sprays prior to entering the dual Fiberglass Reinforced Plastic (FRP) venturis.

Water injected into the venturi throats atomizes and increases particulate precipitation as the gas enters the front section of the FRP packed tower scrubber. The particulates entrapped in water droplets drain into an open blowdown holding area in the bottom of this section. The particulate-free waste gas continues into the downstream section of the scrubber where an alkaline liquid is injected to neutralize acid vapor in the stream. The neutralized and cleaned gas stream exits the scrubber in a single duct leading to an Induced Draft Blower.

4.1.2.8 Exhaust System

The scrubbed gas is drawn from the venturi scrubber by the Induced Draft Blower which propels it up the FRP Exhaust Stack. The exhaust stack is mounted on a pad as a free-standing unit with sampling ladder, platform, and ports attached.

4.1.2.9 Control Van

The System Control Van is a specially designed unit built to house the controls required to start, run, and shut down all subunits. The Control cabinet is located in the rear of the unit and contains all unit alarms, annunciators, recorders, Hand-Off-Auto switches, process controllers, and process indicators. The stack gas analyzer and solid state belt drive controller are located in the middle section and the Motor Control Center is mounted in the front.

4.2 Test Program

The Haztech/Shirco incinerator test program will be conducted with the unit operating at normal conditions. Measurements will be made in triplicate at each sampling location. During one of these three tests, a duplicate set of measurements will be made at each sampling location. Table 4-1 presents a summary of the test program including sampling frequencies, sampling methods and analytical parameters and methods for each sampling location.

4.3 Sampling Locations

This subsection presents a brief description of each location where samples will be collected. The sampling locations are depicted in Figure 4-1. The streams which will be sampled are:

1. Stack Gases;
2. Solid Waste Feed;

TABLE 4-1. SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR THE PEAK OIL SITE, BRANDON, FLORIDA

Source	Sample Collection Frequency	Sampling Method	Analysis Parameters	Analysis Method	
Stack Gas	Composite over 3-6 hour period	EPA Method 5 with 0.1 N NaOH	Particulate Matter HCl Volumetric flowrate Moisture Metals (particulate on filter)	EPA Method 5 Ion Chromatography EPA Methods 1-4 EPA Method 4 SW 6010, 7060, 7041, 7421, 7740, 7470/7471	
	Composite over 3-6 hour period	SASS with XAD-2 (S009)	PCB PCDD/PCDF Semi-volatile Priority Pollutants (plus 10 highest peaks)	EPA 680 SW 8280 SW 8270	*
	Composite over 4 hour period	Modified Method 5 (No filter/0.1 N NaOH)	Soluble Chromium	M218.4	
		Gas Bag (Grab)	CO_2, O_2	EPA Method 3	
	6 pairs of samples over 2 hour period (one aqueous condensate)	VOST/S012	Volatile Priority Pollutants (plus 10 highest peaks)	VOST	*
	Continuous	Continuous emission monitors	O_2 CO_2 CO THC NO_x	Paramagnetic NDIR NDIR FID Chemiluminescence	
Solid Waste Feed	Grab sample every 15 minutes and composite	S007	Chlorine PCB Metals TCLP EP Toxicity Volatile Priority Pollutants (plus 10 highest peaks)	A003 EPA 680 SW 6010, 7060, 7041, 7421, 7740, 7470/7471 ICAP, AA, GC/MS C004 SW 8240	

(Continued)

TABLE 4-1. (Continued)

Source	Sample Collection Frequency	Sampling Method	Analysis Parameters	Analysis Method
Furnace Ash	Grab sample every 15 minutes and	S007	PCB	EPA 680
			PCDD/PCDF	EPA 8280
			Metals	SW 6010, 7060, 7041 7421, 7740, 7470/7471
			EP Toxicity	C004
			TCLP	ICAP, AA, GC/MS
			Volatile Priority Pollutants (plus 10 highest peaks	SW 8240
			Semi-volatile Priority Pollutants (plus 10 highest peaks)	SW 8270, P024b P031
			Moisture, Ash	A001
			Chlorine	A003
Scrubber Liquid Effluent	Grab sample every 15 minutes and composite	S004	PCB	EPA 680
			PCDD/PCDF	EPA 8280
			pH	C002, EPA 9040
			Chloride	Ion Chromatography
			Metals	SW 6010, 7060, 7041, 7421, 7740, 7470/7471, 7470/7471
			EP Toxicity	C004
			TCLP	ICAP, AA, GC/MS
			Volatile Priority Pollutants (plus 10 highest peaks)	SW 8240
			Semi-volatile Priority Pollutants (plus 10 highest peaks)	SW 8270
			Total Organic Carbon	M415.1
			Total Suspended Solids	M160.1
			Total Dissolved Solids	M160.2
Scrubber Solids	Grab sample every 15 minutes and composit	S007	PCB	EPA 680
			Chlorine	A003
			Metals	SW 6010, 7060, 7041 7421, 7740, 7470/7471
			EP Toxicity	C004
			TCLP	ICAP, AA, GC/MS
			Volatile Priority Pollutants (plus 10 highest peaks)	SW 8240

(continued)

TABLE 4-1. (Continued)

Source	Sample Collection Frequency	Sampling Method	Analysis Parameters	Analysis Method
Scrubber Solids (continued)			Semi-volatile Priority Pollutants (plus 10 highest peaks)	SW 8270
			Ash	A003
			Ultimate	A003
Scrubber Water Make-up	Grab sample every 15 minutes and composite	S004	PCB	EPA 680
			PCDD/PCDF	EPA 8280
			pH	C002, EPA 9040
			Chloride	Ion Chromatography
			Metals	SW 6010, 7060, 7041, 7421, 7740, 7470/7471
			Volatile Priority Pollutants (plus 10 highest peaks)	SW 8240
			Semi-volatile Priority Pollutants (plus 10 highest peaks)	SW 8270
			Total Organic Carbon	M415.1
			Total Suspended Solids	M160.1
			Total Dissolved Solids	M160.2
Ambient Air	Continuous over 12-hour period; One upwind and one downwind	PUF	PCB	EPA 680

A-,S- Methods from "Sampling and Analysis for Hazardous Waste Combustion"
M - Methods from "Methods for Chemical Analysis of Water and Wastes"
SW - Methods from "Test Methods for Evaluating Solid Waste"

3. Furnace Ash;
4. Scrubber Liquid Effluent;
5. Scrubber Solids; and
6. Scrubber Water Inlet.

Ambient samples for PCB measurements will be collected at various locations within the plant boundaries. Actual locations can not be determined until sampling commences due to meterological factors (i.e. wind direction, wind speed, rain).

4.3.1 Stack Gases

Gases exiting the scrubber unit are propelled by an induced draft fan and exhausted out a fiberglass-reinforced plastic stack. The stack is mounted on a pad as a free standing unit and has a diameter of 34 inches. Two orthogonal stack sampling ports with 4 inch flanged extensions are approximately 34.5 feet from ground level. Two additional orthogonal 3-inch ports are located about 2 feet above the 4-inch ports. Haztech's continuous monitors utilize one of the 3-inch ports. A sampling platform accessible by a ladder is at the sampling level.

4.3.2 Solid Waste Feed

The solid waste feed samples will be taken at the point where the waste feed transfers from the weigh hopper to the conveyor belt which services the incinerator feed hopper. The solid waste feed drops from the weigh hopper directly onto the feed hopper conveyor providing an easily accessible sampling point. Grab samples will be taken every 15 minutes in a one-liter amber gas bottle.

4.3.3 Furnace Ash

Primary furnace ash is augered from the primary incineration chamber to a metal holding bin. The ash is removed from the bin by a front-end loader and deposited on a concrete pad prior to disposal. The ash sample will be scooped directly from the ash bin. Grab samples will be taken every 15 minutes in a one-liter amber glass bottle.

4.3.4 Scrubber Liquid Effluent

Scrubber water injected into the venturi throats is collected and transferred to a holding pond. Samples of the scrubber liquid effluent will be taken from a tap on the positive pressure side of the scrubber water recirculation pump. Grab samples will be taken every 15 minutes in a 500 ml amber glass bottle and two 40 ml VOA vials.

4.3.5 Scrubber Solids

Particulate matter and salts are removed from the exhaust gas by two venturis. Scrubber water is returned to a polyethylene-lined, above ground holding tank where the particulate matter and salts settle out and collect on the floor of the tank. The waist-high holding container is easily accessible by a scoop for collection of solids from the floor of the tank. Grab samples will be taken every 15 minutes in a one-liter amber glass bottle.

4.3.6 Scrubber Water Inlet

Samples of the scrubber make-up water will be taken from a tap on the positive pressure side of the scrubber make-up water pump. Grab samples will be taken every 15 minutes in a 500 mL amber glass bottle and in two 40 ml VOA vials.

4.3.7 Ambient Emissions *

Ambient concentrations of PCBs will be monitored during testing at *
site boundaries. One upwind and one downwind ambient air sample will be *
collected daily. The samples will be collected over 24 hours. *

4.3.8 Process Data

Haztech operating personnel will record process data during the test periods at hourly intervals. Figure 4-2 presents the process data sheet which will be used to record the data.

4.4 Sampling Procedures

This section describes in detail the sampling methods and procedures to be used during the Haztech/Shirco incinerator demonstration test for collection of samples of the stack gas and liquid and solid samples and ambient air. Process data will also be collected.

4.4.1 Stack Gas Sampling Procedures

Sampling procedures for collection of stack gas samples are described in the following sections.

4.4.1.1 EPA Method 5

The stack gas will be sampled for measurement of particulate matter, HCl, volumetric flow rate, moisture, and metals using an EPA Method 5 sampling train. The method will be modified by including 0.1 N NaOH in the impingers to collect HCl. The Method 5 sampling train is shown in Figure 4-3.

Based on the Method 5 technique, a sample of particulate-laden flue gas is withdrawn isokinetically using a gooseneck nozzle and heat-traced, glass-lined probe. The particulate matter is collected on a glass fiber filter maintained at a temperature in the range of 248 $\pm 25^{\circ}$F. The particulate mass is determined gravimetrically from the residues collected on the filter and in the probe and associated glassware prior to the filter. After the filter, the flue gas enters a chilled impinger train where HCl is collected in

HAZTECH/SHIRCO INCINERATOR
PROCESS DATA RECORDING SHEET

DATE ________ OPERATOR ____________

	TAG NO.	UNITS	TIME				
TEMPERATURE DATA							
PCC SECTION A1							
PCC SECTION A2							
PCC SECTION A3							
PCC SECTION B1							
PCC SECTION B2							
PCC SECTION B3							
PCC EXHAUST							
SCC EXHAUST							
SCC MIDDLE							
SCRUBBER QUENCH #1							
SCRUBBER QUENCH #2							
ASH DISCHARGE							
EXHAUST STACK							
FLOW DATA							
SOLID WASTE FEED RATE							
QUENCH WATER #1							
QUENCH WATER #2							
QUENCH RECYCLE #1							
QUENCH RECYCLE #2							

(Page 1 of 2)

Figure 4-2. Haztech/Shirco Incinerator Process Data Recording Sheet. (Page 1 of 2 Pages)

HAZTECH/SHIRCO INCINERATOR
PROCESS DATA RECORDING SHEET

DATE ________ OPERATOR ____________

	TAG NO.	UNITS	TIME				
VENTURI RECYCLE #1							
VENTURI RECYCLE #2							
CHEVRON RECYCLE #1							
CHEVRON RECYCLE #2							
ASH QUENCH RATE							
PCC AIR FLOW							
SCC AIR FLOW							
SCC FUEL FLOW							
VENTURI PRESSURE DATA							
VENTURI ΔP #1							
VENTURI ΔP #2							
PCC PRESSURE							
SCC PRESSURE							
ID FAN SUCTION							
MISCELLANEOUS DATA							
STACK GAS VELOCITY							
SCRUBBER SOLUTION pH							
SCC O_2							
STACK CO2							
STACK CO							
BELT SPEED							
ELECTRIC POWER TOTAL							
ELEC. PWR.-PCC/HEPC							

(Page 2 of 2)

Figure 4-2. Haztech/Shirco Incinerator Process Data Recording Sheet. (Page 2 of 2 Pages)

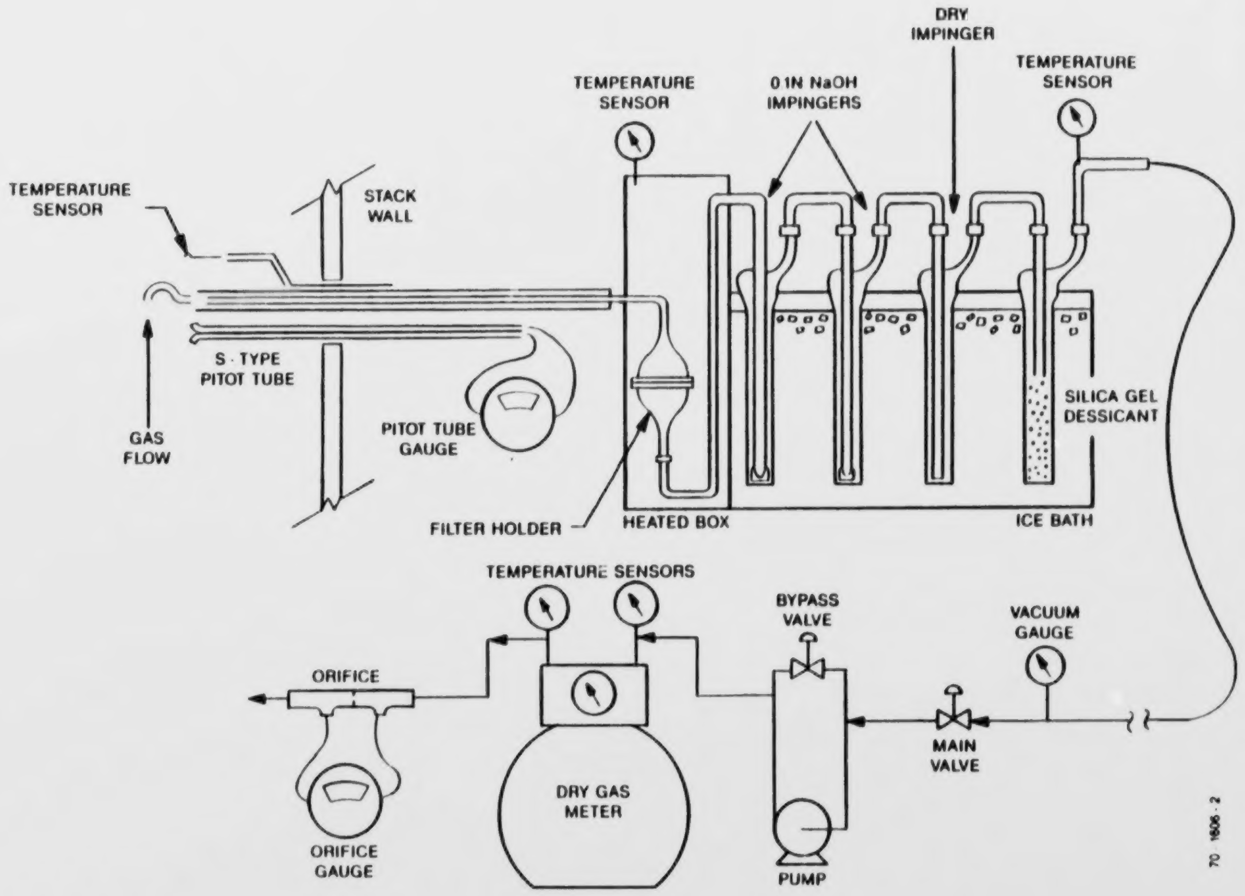

TEMPERATURE SENSOR
STACK WALL
GAS FLOW
S-TYPE PITOT TUBE
PITOT TUBE GAUGE
FILTER HOLDER
TEMPERATURE SENSOR
HEATED BOX
0.1N NaOH IMPINGERS
DRY IMPINGER
TEMPERATURE SENSOR
SILICA GEL DESSICANT
ICE BATH
TEMPERATURE SENSORS
BYPASS VALVE
VACUUM GAUGE
MAIN VALVE
ORIFICE
ORIFICE GAUGE
DRY GAS METER
PUMP
70 1606-2

Figure 4-3. Schematic of the EPA Method 5 Sampling Train for Particulate Matter and HCl.

the first two Greenburg-Smith impingers containing 200 mL of 0.1 N NaOH. A third dry impinger follows to collect condensate or mist carryover from the previous impingers. The third impinger will be a modified Greenburg-Smith type. The fourth impinger will contain a known weight of silica gel desiccant to collect remaining moisture. A pump and dry gas meter are used to control and monitor the gas flow rate.

During collection of EPA Method 5 samples, S-type pitot measurements are taken at traverse points in the flue gas duct to determine the isokinetic sampling rate. The pitot differential pressure measurements, along with the flue gas composition (CO_2, O_2, N_2, H_2O), are also used to determine the volumetric flue gas flow rate by correlation to the cross-sectional area of the duct at the sampling location. During the sampling runs, grab samples of the stack gas will be collected to determine the concentrations of CO_2 and O_2 directly and N_2 by difference, in accordance with EPA Reference Method 3 protocol. The moisture content of the sample gas will be measured during the runs following EPA Reference Method 4 protocol.

At the end of the sampling period, the nozzle, probe liner, and glassware preceding the filter housing are rinsed with acetone and deionized water to remove particulate matter. The resulting wash is evaporated and the mass of particulate remaining is determined. The glass fiber filter is removed from the filter holder, desiccated for 24 hours, and weighed to determine the mass of particulate on the filter. The total mass of particulate present on the filter and in the probe wash is then related to the total volume of gas sampled to determine the particulate loading.

The impingers used during particulate sampling are weighed before and after sampling to determine the moisture content of the flue gas. The HCl concentration of the flue gas is determined by analyzing two sodium hydroxide impingers for chloride. Since the impinger solutions are caustic, CO_2 will also be removed. To account for the CO_2 removal, the 0.1 N NaOH impinger solutions will also be analyzed for carbonate. The metered gas sample volume will be adjusted using the carbonate analytical values.

The particulate matter collected on the glass fiber filter will be analyzed for metals. The measured metals concentration along with the particulate loading and flue gas flow rate will be used to determine the emission rates of those metals.

4.4.1.2 Source Assessment Sampling System

The Source Assessment Sampling System (SASS) will be utilized during this program for the determination of semivolatile priority pollutants (plus 10 highest peaks) [SV-PP+10], PCDD/PCDF, and PCBs. XAD-2 will be the adsorbent resin in the train. Samples for PCBs will be collected in a separate SASS train from the samples collected for PCDD/PCDF and SV-PP+10.

PCBs, SV-PP+10 and PCDD/PCDF

A SASS train will be used to collect samples of the stack gases for the determination of PCBs, SV-PP+10, and PCDDs/PCDFs. The SASS protocol is outlined in "Modified Method 5 Train and Source Assessment Sampling System Operator's Manual," February 1985, by the U.S. Department of Commerce (NTIS) and "Sampling and Analysis Methods for Hazardous Waste Combustion", EPA (Method 009).

A sorbent module containing an organic adsorption resin (XAD-2) will be used to efficiently collect vapor phase organics. The SASS train for collection of PCBs, SV-PP+10, and PCDDs/PCDFs is shown in Figure 4-4.

The sampling system consists of a heated probe, a heated filter, a condenser, a sorbent module, and a pumping and metering unit. Because of the low particulate loading in the gas stream, the three cyclones of the SASS have been removed from the train for sampling. The probe is a stainless steel

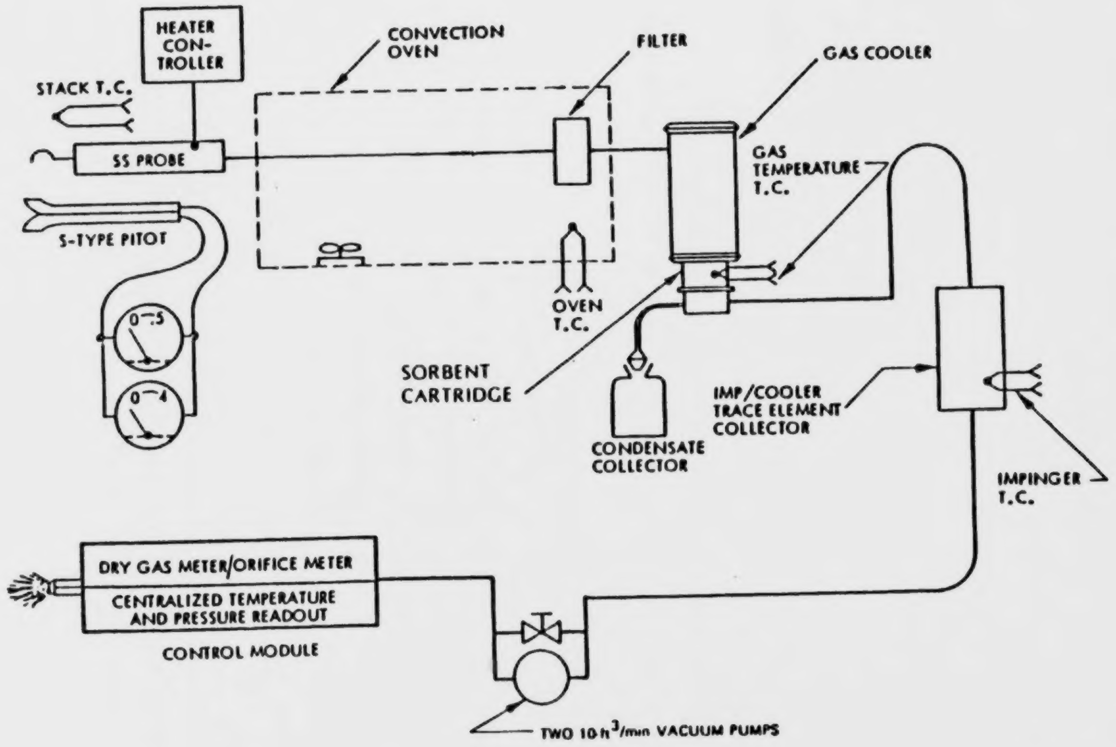

HEATER CON-TROLLER
STACK T.C.
SS PROBE
S-TYPE PITOT
0–.5
0–4
CONVECTION OVEN
FILTER
OVEN T.C.
GAS COOLER
GAS TEMPERATURE T.C.
SORBENT CARTRIDGE
CONDENSATE COLLECTOR
IMP/COOLER TRACE ELEMENT COLLECTOR
IMPINGER T.C.
DRY GAS METER/ORIFICE METER
CENTRALIZED TEMPERATURE AND PRESSURE READOUT
CONTROL MODULE
TWO 10-ft^3/min VACUUM PUMPS

Figure 4-4. Source Assessment Sampling System Train

sheath which contains a heat-traced stainless steel sample liner. A gooseneck nozzle of proper size to allow near-isokinetic sample collection is attached to the probe. The flue gas velocity is measured at the nozzle tip by an S-type pitot, using either an oil manometer or Magnehelic® differential pressure gauge to measure the ΔP of the pitot. The probe fixes to the heated enclosure which houses a high efficiency glass fiber filter. The enclosure is maintained at a temperature of 400°F.

From the heated filter, the sample gas enters a water-cooled condenser, followed by the XAD-2 sorbent module. A condensate trap follows the sorbent module which will collect the aqueous condensate.

After the condensate trap are three dry impingers to collect any mist carryover from the condensate trap and a final impinger containing a desiccant to dry the sample gas prior to metering. The sample gas is drawn by two double diaphragm pumps, and the sample gas volume is measured using a dry gas meter.

The design of the SASS train precludes traversing of the stack. Sample collection is performed at a single point of average gas velocity based on previously-determined velocity traverse data. The SASS probe includes an S-type pitot and thermocouple to measure sample gas velocity to determine the isokinetic flowrate.

Conventionally, 30 cubic meters of 1,060 cubic feet of gas are sampled. Sample collection time will be approximately three to six hours. The allowable isokinetic sampling rate for the SASS is -70 to±150 percent.

Sampling train preparation and sample retrieval will be performed indoors in a controlled environment to reduce the possibility of sample contamination. Prior to assembly, each component of the sampling train will be thoroughly rinsed with methylene chloride. The glass fiber filter will be pre-extracted with methylene chloride. All connections in the sampling train will be installed dry, or where possible, with Teflon to reduce the possibility of contamination. Once the sampling train has been assembled, the nozzle

and exit port will be sealed with methylene chloride-rinsed foil. The data *
sheet presented in Figure 4-5 will be used to document pertinent source *
sampling information during the SASS and EPA Method 5 samples. *

After sample collection, the ends of the sampling train will once *
again be sealed with solvent-rinsed foil and returned to the clean-up area for *
sample retrieval. The filter will be recovered and placed in a methylene *
chloride-rinsed glass petri dish. Aqueous condensate collected in the *
condensate trap and in the impingers will be transferred to methylene chlo- *
ride-rinsed amber glass bottles with Teflon®-lined closures. All components *
of the sampling train, from the nozzle through the sorbent module and includ- *
ing the probe, filter glassware, and impinger glassware, will be thoroughly *
rinsed. *

4.4.1.3 Soluble Chromium

Soluble chromium (Hexavalent Chromium) sampling will be conducted according to the procedures (with modifications) currently being used by the EPA's Emission Measurement Branch (EMB) for sampling hexavalent chromium emissions from municipal waste incinerators. This procedure involves the use of an EPA Method 5 sampling train with the following modifications:

- 0.1 N NaOH impingers in place of water;
- No filter;
- A glass nozzle in place of stainless steel;
- 0.1 N NaOH rinse to recover the sample; and
- Minimal 0.1 N NaOH in the sample recovery process.

The nozzle, probe liner, and pre-impinger glassware rinse will be added to the impinger catches and the sample analyzed by atomic absorption spectroscopy. The soluble chromium sampling train will be run approximately 4 hours at a point of average flue gas velocity to achieve adequate analytical sensitivity.

A01 (1-3) Plant Name>________________________________
Sampling Location>____________________ Sample Ident.>____________
A02 (1-3) Date ________ (4:6) (MMDDYY) Time Start ________ (11:4) (HHMM) Time Finish ________ (18:4) (HHMM)
Duct Dimensions ______ (25:3) x ______ (32:3) ft. or Diameter ____________ (39:5) ft.
PTCF ________ (46:5) DGMCF ________ (53:5) Test Duration ____________ (60:5) min.
A03 (1-3) Nozzle Dia. ____________ (4:6) inches % CO ____________ (11:6) % N_2 ____________ (18:6)
Bar Press. ____________ (25:6) "Hg % CO_2 ____________ (32:6) % H_2 ____________ (39:6)
Static Press. ____________ (46:6) "H_2O ____ (53) % O_2 ____________ (60:6) % CH_4 ____________ (67:6)
A04 (1-3) Initial leak rate ________ (4:6) cfm Condensed Water ____________ (11:6) gms
Final leak rate ________ (18:6) cfm Filter wt. gain ____________ (25:7) gms
Operator initials ________ (32:7) Probe wash wt. gain ____________ (39:7) gms

	Pt.	Clock Time	Dry Gas Meter Reading ft³	ΔP in. H_2O	ΔH in. H_2O	Stack Temp. °F	Dry Gas Meter Temperature		Hot Box Temp. °F	Last Impinger Temp. °F	L. Vac. in. Hg Gauge
							Inlet °F	Outlet °F			
A05											
A06											
A07											
A08											
A09											
A10											
A11											
A12											
A13											
A14											
A15											
A16											
A17											
A18											
A19											
A20											
A21											
A22											
	(4:2)	(11:4)	(18:7)	(25:6)	(32:6)	(39:6)	(46:6)	(53:6)	(60:6)	(67:5)	(74:5)

Console____________ Filter____________ Initial Wt.____________gms
Sample Analysis________________________________
Weather________________________________
____
A23 Remarks________________________________
____

Figure 4-5. Source Sampling Data Sheet.

4.4.1.4 VOST

The stack gas will be sampled for volatile organic compounds and priority pollutants (plus the 10 highest peaks) using the VOST (Volatile Organics Sampling Train). The VOST is based upon the design described in a 1984 publication, "Protocol for the Collection and Analysis of Volatile POHCs using VOST," prepared for EPA's Industrial Environmental Research Laboratory. The VOST is designed to collect volatile organics with boiling points less than approximately 100°C using a pair of adsorbent resin traps in series.

A schematic diagram of the VOST sampling train is shown in Figure 4-6. Volatile organics are removed from the gas in sorbent resin traps containing Tenax and Tenax-charcoal maintained at 20°C. The first resin trap contains Tenax and the second trap contains Tenax followed by petroleum-based charcoal. After sampling, the resin traps are sealed and returned to the laboratory for analysis. A 20-L sample of gaseous effluent is collected at a * flow rate of 0.5 L/min using a glass-lined probe. A dry gas meter is used to * measure the volume of gas passed through the pair of traps. An example VOST source sampling data sheet is shown in Figure 4-7.

During the test, a VOST run will consist of collecting six pairs of traps, with each pair of traps exposed to sample gas for 20 minutes at the 1.0 L/min flow rate. After daily sampling, two 40 ml VOA vials will be used to collect the aqueous condensate collected in the condenser. Three analyses will be performed on the six resin trap pairs and on one of the aqueous condensate vials. The samples will be collected at a fixed point of average gas velocity in the duct. Isokinetic sampling is not required since the volatile POHCs are in the gas phase.

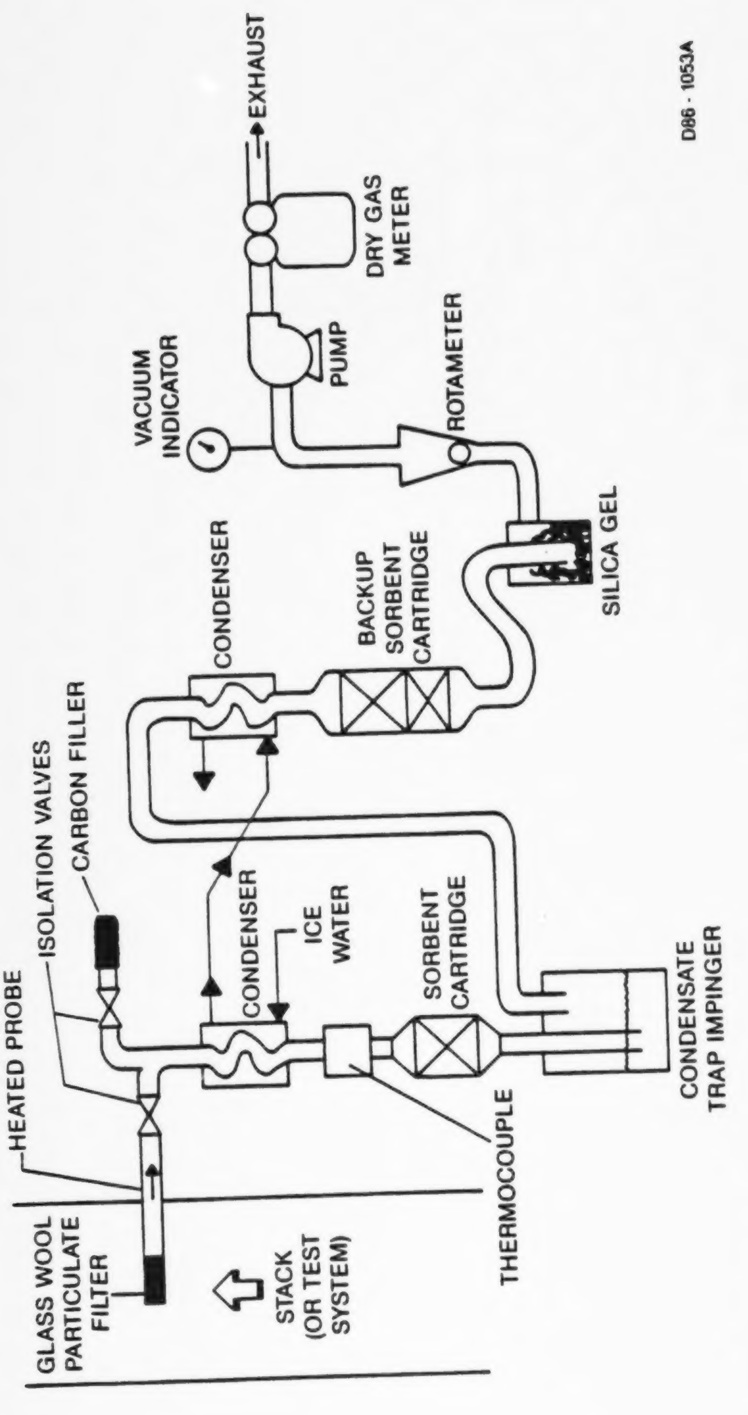

GLASS WOOL PARTICULATE FILTER
STACK (OR TEST SYSTEM)
HEATED PROBE
ISOLATION VALVES
CARBON FILLER
THERMOCOUPLE
CONDENSER
ICE WATER
SORBENT CARTRIDGE
CONDENSATE TRAP IMPINGER
CONDENSER
BACKUP SORBENT CARTRIDGE
SILICA GEL
VACUUM INDICATOR
ROTAMETER
PUMP
DRY GAS METER
EXHAUST
D86 - 1053A

Figure 4-6. Schematic Diagram of VOST Sampling Train

VOST Field Data Sheet

Plant ______________________
Date ______________________
Location ______________________
Console # ______________________
DGMCF ______________________

Field Blank ID: Tenax ______________
Tenax/Charcoal ______________
Operator ______________
Barometric Pressure ______________
Sampling Duration ______________

Pair No.	Leak Check	Rotameter (l/min)	DGM Reading (L)		Time	Probe Temp.	Condenser Outlet Temp.	Meter Temp.		Meter Pressure	Pump Vacuum (in - Hg)
			Initial	Final				Inlet	Outlet		

Condensate Samples:
Run No. ______________
Sample ID ______________

Comments:

Figure 4-7. VOST Source Sampling Data Sheet

Descriptions of the train components are given below:

Probe--The probe is lined with borosilicate or quartz glass. The glass liner provides an inert surface so that the sample gas does not undergo changes in composition. The liner is equipped with a connecting fitting that is capable of forming a leak-free connection without sealing greases. The probe is maintained at a temperature of at least 130°C prior to the first condenser.

Isolation Valve--The isolation valve is a greaseless stopcock with a glass bore and a sliding Teflon® plug with Teflon® wipers.

Condensers--The condensers are of sufficient capacity to cool the gas stream to 20°C or less prior to the first sorbent trap. The condensers are fitted with leak-free connections.

Sorbent Traps--The sorbent traps are of the inside-inside type as illustrated in Figure 4-8. The cartridge is approximately 1.6 centimeters I.D. and 10 centimeters long. The first trap in the series is packed with approximately 1.6 grams of Tenax GC resin. The second trap is packed with approximately 1 gram each of Tenax GC resin and petroleum-based charcoal. The second trap is packed so that the sample gas passes through the Tenax layer first and then through the charcoal layer.

Metering System--The metering system consists of vacuum gauges, a leak-free pump, a calibrated rotometer, a dry gas meter accurate to within ±2 percent at the required sampling rate, and related valves and equipment. A thermocouple is placed on the exterior glass surface at the exit of the first condenser to monitor and maintain the gas temperature entering the first sorbent trap at 20°C or less.

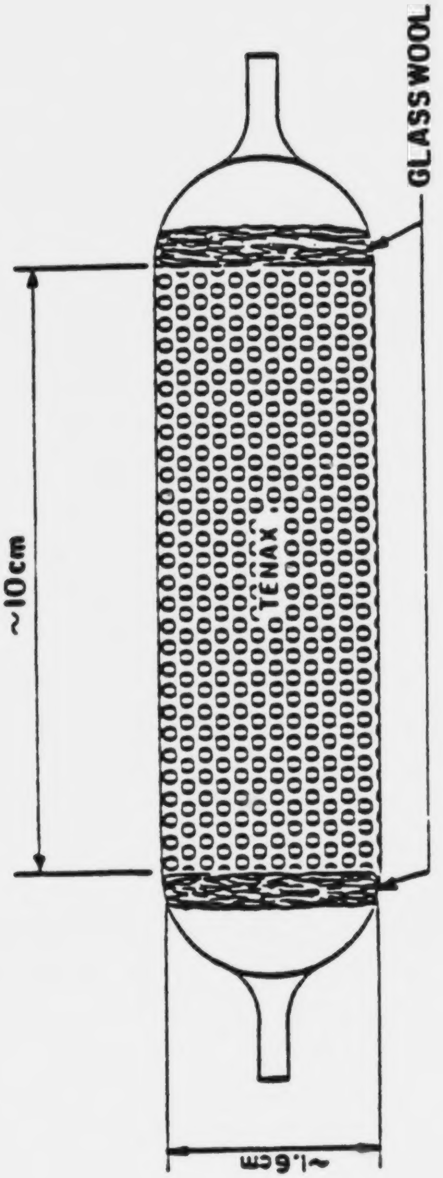

GLASS WOOL
TENAX
~10cm
~1.6cm

Figure 4-8. Inside-Inside VOST Cartridge

Sampling train preparation and sample retrieval will be performed indoors in a controlled environment to reduce the possibility of sample contamination. Prior to assembly, all sample contacting components will be cleaned with a non-ionic detergent, rinsed in HPLC-grade distilled water, and dried at 110°C. Resin tubes will be stored in cleaned glass containers with Teflon^r-lined screw caps. Condensers and other glassware will be capped with appropriate end caps prior to use.

At Radian laboratories, the Tenax and Tenax-charcoal cartridges will be loaded and leak-checked using the following procedures.

The traps are marked to show the flow direction for sampling, so that when the Tenax-only traps are returned to the laboratory for analysis, they can be spiked for QA/QC purposes and connected to the analytical system in the proper orientation. The Tenax-only traps contain 1.6 grams of Tenax, and the Tenax-charcoal traps contain 1 gram of Tenax and 1 gram of charcoal. This appears visually as 2/3 Tenax and 1/3 charcoal by volume. The traps are conditioned prior to use. The conditioning operation includes conditioning of not only the trap but also the Teflon®-filled ceramic ferrules and hardware used in connecting the trap.

The virgin Tenax is prepared by Soxhlet extraction with methanol and then pentane for 24 hours each and dried in a vacuum for 6 hours at 50°C. (The charcoal is prepared in the same manner.) The tubes are then packed individually and thermally conditioned for 24 hours at 200° with organic-free nitrogen (or helium) flowing at 30 mL/min. The effluent from the conditioning system is monitored with a flame ionization detector to check for emissions of volatile organic compounds. Conditioning is repeated until no emissions are observed at the detection limit of 2 ng of benzene and/or toluene by cyrofocusing GC/FID detector. One out of every 10 tubes is screened further by treating it as a sample and performing an analytical thermal desorption step. Subsequent conditioning (after sampling and analytical desorption) will include only the thermal steps unless the tubes have experienced unusually high levels of organic compounds, in which case, both Soxhlet extraction and thermal conditioning are measured with the tube having the lowest flow being selected for the additional screening step.

After sample collection, the cartridges will be leak-checked again. After leak checks have been completed at the end of sampling with each pair of traps, the traps will be sealed with their end caps and returned to their respective glass containers for storage and transport. During transportation and storage, the traps will be maintained at $4^{o}C$ until analysis.

4.4.1.6 Molecular Weight

Stack gas will be collected at a single point in the stack in gas bags for determination of O_2 and CO_2 concentrations. The sample will be extracted through a stainless steel probe and passed through a silica gel impinger to dry the gas before collection in the gas bag. Analysis will be conducted by EPA Method 3.

4.4.1.7 Continuous Emission Monitors (CEMs)

CEMs will be used during the demonstration test to continuously monitor the concentrations of CO, CO_2, O_2, NO_x, and THC at the stack. Stack gas will be withdrawn from the stack and transported to the instrumentation located at ground level. A stainless steel probe will be inserted into the stack, and a heat-traced Teflon® sample line will be used to transport the sample to the instrumentation. The sample line will be maintained at a temperature of $300^{o}F$. The stack gas will be conditioned prior to analysis removing both particulate matter and water.

Stack gas will first enter an impinger train having a series of short-stemmed impingers (as condensers) immersed in an ice bath. After the impinger train, particulate matter will be removed by a glass fiber filter. After filtration, the stack gas will be further dried using a Perma-Pure dryer which utilizes a water vapor permeable membrane.

The stack gas will be drawn by a Teflon®-coated diaphragm pump located between the filter and the Perma-Pure dryer. Stack gas for the four instruments will be drawn from a manifold downstream of the pump.

A brief description of each CEM instrument is provided below.

Carbon Monoxide

A Bendix Model 85-105CA analyzer will be used to measure CO concentration in the stack gas. This instrument is a non-dispersive infrared (NDIR) analyzer which measures the concentration of CO by infrared absorption at a characteristic wavelength.

Carbon Dioxide

To measure the CO_2 concentration in the stack gas, an MSA Model 303 non-dispersive infrared (NDIR) analyzer will be used. This instrument measures the concentration of CO_2 by infrared absorption at a characteristic wavelength.

Oxygen

A Taylor Model 540A oxygen analyzer will be used to determine the O_2 concentration of the stack gas. The Taylor 540A measures oxygen concentrations on the basis of the strong paramagnetic properties of O_2 compared to other compounds present in combustion gases. In the presence of a strong magnetic field, O_2 molecules become temporary magnets. The Taylor 540A determines the sample gas O_2 concentration by detecting the displacement torque of the sample test body in the presence of a magnetic field.

Nitrogen Oxides (NO_x)

A TECO Model 10 analyzer will be used to measure the concentration of NO_x present in the stack gas. This instrument determines NO_x

concentrations by converting all nitrogen oxides present in the sample gas to nitric oxide and then reacting the nitric oxide with ozone. The reaction produces a chemiluminescence proportional to the NO_x concentration in the sample gas. The chemiluminescence is measured using a high-sensitivity photomultiplier.

Total Hydrocarbons (THC)

A Beckman Model 400A will be used to continuously measure the concentration of hydrocarbons present in the flue gas. The analyzer utilizes a hydrogen flame ionization detector. The sensor is a burner where a regulated flow of sample gas passes through a flame sustained by regulated flows of a fuel gas and air. Within the flame, the hydrocarbon components of the sample stream undergo a complex ionization that produces electrons and positive ions. Polarized electrodes collect these ions, causing current to flow through an electronic measuring circuit. The ionization current is proportional to the rate at which carbon atoms enter the burner and is, therefore, a measure of the concentration of hydrocarbons in the original sample.

4.4.2 Solid and Liquid Sampling Procedures

Sampling procedures which will be used to collect samples from solid and liquid streams are described in this section.

4.4.2.1 Solid and Liquid Sample Container Preparation

Sample containers for the solid and liquid samples must be organic free and sealed prior to receipt in the field. All sample bottles used for solid and liquid samples will be amber glass with Teflon® cap liners.

All sample bottles will be purchased new from I-Chem Research, Inc. in Hayward, California. Each sample bottle that will be used to store samples for organic analysis will be pre-cleaned using the following procedure:

- Clean initially with a phosphate-free soap;
- Rinse three times with tap water;
- Rinse three times with deionized water;
- Rinse with nitric acid;
- Rinse three times with deionized water;
- Rinse with methylene chloride;
- Bake in an oven for 6 hours at 200°C; and
- Allow to cool and then cap.

4.4.2.2 Solid Sampling Procedures

Samples of the solid waste feed, furnace ash, and scrubber solids will be collected using a trowel or scoop as specified in U.S. EPA Method S007, "Sampling and Analysis Methods for Hazardous Waste Combustion." Solid grab samples will be taken at one-hour intervals. Approximately 1000 g of solid waste feed will be collected for each grab sample. The individual solid grab samples from each run will be composited into a single sample prior to analysis. The total mass of the composited solid sample will be no less than 1000 g.

4.4.2.3 Liquid Sampling Procedures

Scrubber liquid effluent and scrubber water inlet samples will be collected using the tap sampling procedure specified in U.S. EPA Method S004, "Sampling and Analysis Methods for Hazardous Waste Combustion." Liquid samples will be collected hourly during each sampling period. The sample tap will be flushed each time (allowed to flow briefly) before the sample is collected. This will ensure that any stagnant accumulation of solids, or other contaminants that may be present in the tap, do not affect the sample integrity or its representation of the liquid process stream.

For the integrated grab sample, a minimum of 100 mL will be collected from each grab subsample; the total grab sample volume for the run will be about 1-2 L.

At each sample collection, two 40 mL VOA sample vials will also be collected for analysis of V-PP+10. The vials will be filled completely and no air bubbles allowed to remain in the bottles. The VOA samples will be composited at the time of analysis by syringe accumulation from the selected subsamples to provide one sample per test period for analysis.

4.5 Calibration Procedures

Information is presented in this section pertaining to the calibration of sampling equipment. Included are descriptions of each procedure or references to applicable standard operating procedures, the frequency of calibrations, and the calibration standards to be used. Calibration frequency of the field sampling equipment is presented in Table 4-2.

4.5.1 Sampling Equipment Calibration Procedures

An important function in maintaining data quality is the checkout and calibration of the source sampling equipment. Using referenced procedures, the equipment will be calibrated prior to field sampling at the Radian laboratories and the results will be properly documented and retained. If a referenced calibration technique for a particular piece of apparatus is not available, then state-of-the-art techniques are used. A discussion of the procedures used to calibrate this equipment is presented below.

4.5.1.1 S-Type Pitot Tube Calibration

The EPA has specified guidelines concerning the construction and geometry of an acceptable S-type pitot tube. If the specified design and construction guidelines are met, a pitot tube coefficient of 0.84 can be used. Information related to the design and construction of the S-type pitot tube is presented in detail in Section 3.1.1 of EPA document 600/4-77-027b (6). Only S-type pitot tubes meeting the required EPA specifications will be used during

TABLE 4-2. CALIBRATION FREQUENCY OF FIELD SAMPLING EQUIPMENT

Sampling Equipment	Calibration Frequency		
	Before Sampling	Daily	After Sampling
S-Type Pitot Tube	*		
Sampling Nozzle	*		
Differential Pressure Gauge	*		*
Temperature Measuring Devices	*		
Dry Gas Meters	*		*
Analytical Balance	*		
CEMs	*	*	*

this project. Prior to the field sampling, the pitot tubes will be inspected and documented as meeting EPA specifications. An example of the pitot inspection sheet is presented in Figure 4-9.

4.5.1.2 Sampling Nozzle Calibration

EPA Method 5 prescribes the use of stainless steel gooseneck nozzles for isokinetic particulate sampling. Calculation of the isokinetic sampling rate requires that the cross-sectional area of the sampling nozzle be accurately and precisely known. All nozzles used for the EPA Method 5 particulate sampling and Modified Method 5 sampling will be thoroughly cleaned, visually inspected, and calibrated according to the procedure outlined in Section 3.4.2 of EPA document 600/4- 77-027b. According to this procedure, three measurements of the inside diameter of the nozzle will be made on different diameters. Using a Vernier caliper, measurements will be made to the nearest 0.001 inch. Nozzles will be considered acceptable if the difference between any two measurements is less than 0.004 inches. A nozzle calibration data sheet is shown in Figure 4-10.

4.5.1.3 Differential Pressure Gauge Calibration

Magnehelic® gauges will be used during this project to measure differential and static pressures. In Section 3.1.2 of EPA document 600/4-77-027b, the technique used to calibrate the Magnehelic® is described. This technique requires that ΔP readings obtained with the Magnehelic® be compared directly to that of a gauge oil manometer. The Magnehelic® gauges will be calibrated prior to field sampling and checked at a single representative value following the field sampling. An example Magnehelic® gauge calibration form is shown in Figure 4-11.

4.5.1.4 Temperature Measuring Device Calibration

During source sampling, accurate temperature measurements are required. Thermocouple temperature sensors will be calibrated using the

PITOT TUBE INSPECTION FORM

Date: ____________________ Operator Initials: ____________________

Pitot Tube I.D. No.: ____________ Length: ____________________

Pitot tube assembly level? ____________ yes ____________ no

Pitot tube openings damaged? ____________ yes (explain below) ________ no

Quick connects attached, leak free? ____________ yes ____________ no

α_1 = ____________° α_2 = ____________°

β_1 = ____________° β_2 = ____________°

γ = ____________°, θ = ____________°, A = ____________ cm (in.)

z = A sin γ = ____________ cm (in.);

w = A sin θ = ____________ cm (in.);

P_A = ____________________ cm (in.);

P_b = ____________________ cm (in.);

D_t = ____________________ cm (in.)

Acceptance Criteria:

α_1 and α_2 < 10° ____________ yes ____________ no

β_1 and β_2 < 5° ____________ yes ____________ no

z < 0.32 cm (1/8 in.) ________ yes ____________ no

w < 0.08 cm (1/32 in.) ________ yes ____________ no

P_A and P_b, 1.05 D_t < P < 1.50 D_t ____________ yes ____________ no

D_t, 0.48 cm (3/16 in) ≤ D_t ≤ 0.95 cm (3/8 in) ____________ yes ____________ no

Pitot Tube Acceptable? ____________ yes ____________ no

Comments: ____

____

____

Figure 4-9. Example of the Pitot Inspection Sheet

Date (DDMMYY): ____________________

Initials of Calibrator: __________

Nozzle Identification No.	D_1 (inches)	D_2 (inches)	D_3 (inches)	Average Diameter (inches)

NOTE: The maximum acceptable difference between any two measurements is 0.004 inches. If this tolerance cannot be met, the nozzle should not be used.

Figure 4-10. Nozzle Calibration Data Sheet

DATE: ______________________ OPERATOR INITIALS: ____________

TYPE OF MAGNEHELIC (CIRCLE ONE): ΔP , ΔH , SPARE

MAGNEHELIC I.D. NO. ______________ RANGE: ________ " H_2O

REFERENCE MANOMETER ΔP_1	MAGNEHELIC ΔP_2	% ERROR $\frac{\Delta P_1 - \Delta P_2}{\Delta P_1}$ x 100
①		
②		
③		
④		
⑤		

DATE: ______________________ OPERATOR INITIALS: ____________

TYPE OF MAGNEHELIC (CIRCLE ONE): ΔP , ΔH , SPARE

MAGNEHELIC I.D. NO. ______________ RANGE: ________ " H_2O

REFERENCE MANOMETER ΔP_1	MAGNEHELIC ΔP_2	% ERROR $\frac{\Delta P - \Delta P_2}{\Delta P_1}$ x 100
①		
②		
③		
④		
⑤		

Figure 4-11. Differential Pressure Gauge Calibration Form

procedure described in Section 3.4.2 of EPA document 600/4-77-027b. Each temperature sensor will be calibrated at a minimum of three points over the anticipated range of use against a NBS-traceable mercury-in-glass thermometer. All sensors will be calibrated prior to field sampling. Figure 4-12 presents an example calibration form.

4.5.1.5 Dry Gas Meter Calibration

Dry gas meters (DGMs) will be used in the SASS Modified Method 5, Method 5, and VOST trains to monitor the sampling rate and to measure the sample volume. All dry gas meters will be calibrated (documented correction factor at standard conditions) just prior to the departure of the equipment to the field. A post-test calibration check will be performed as soon as possible after the equipment has been returned to Radian in Austin, Texas. The pre- and post-test calibrations should agree within 5 percent.

The dry gas meters to be used in the SASS Modified Method 5, and Method 5 trains will be calibrated using the calibration system illustrated in Figure 4-13. Using the procedure outlined in Section 3.3.2 of EPA document 600/4-77-237b, a positive pressure leak-check of the system will be performed prior to calibration. To perform the leak-check, the system is placed under approximately ten inches of water pressure and a gauge oil manometer is used to determine if a pressure decrease can be detected over a one-minute period. If leaks are detected, they will be eliminated before actual calibrations are performed.

To calibrate a dry gas meter, the pump will be allowed to run for 15 minutes after the sampling console is assembled and leak-checked. Once the pump and dry gas meter are warmed up, the valve on the console is adjusted to obtain the desired flow rate. After 10 minutes, the valve is closed and a final set of data is recorded. A duplicate calibration is then performed at the same flow rate. If necessary, additional calibrations are conducted until

TEMPERATURE INDICATOR IDENTIFICATION NO. (T_{Test})	NBS THERMOMETER SERIAL NO. (T_{STD})	DATE (MMDDYY)	INITIALS OF CALIBRATOR	CALIBRATION DATA	
				MEASURED T_{Test}	MEASURED T_{STD}

Figure 4-12. Temperature Sensor Calibration Form

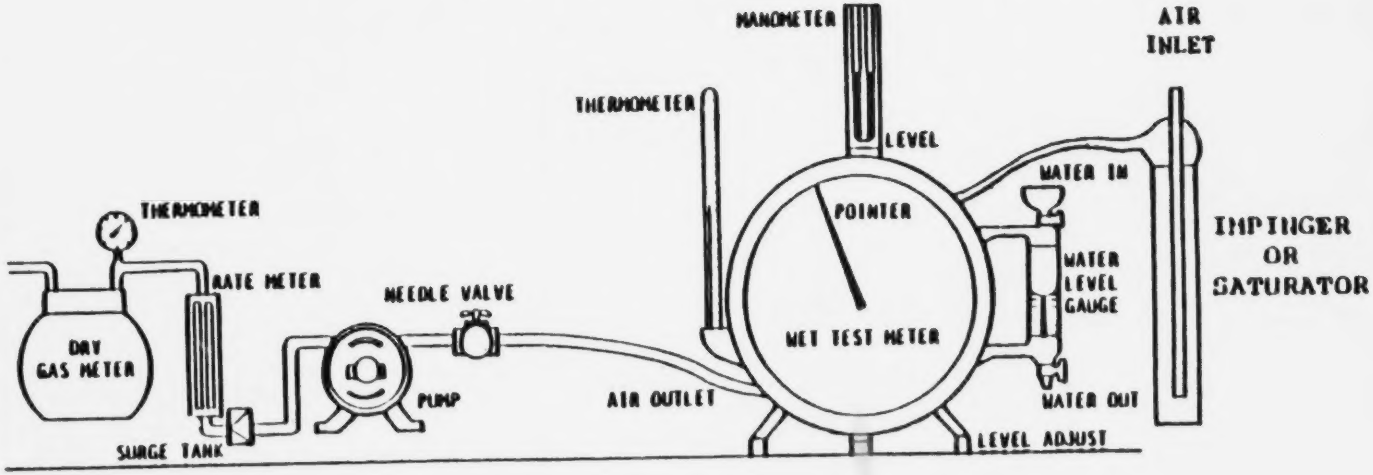

MANOMETER
AIR INLET
THERMOMETER
LEVEL
WATER IN
THERMOMETER
POINTER
IMPINGER OR SATURATOR
WATER LEVEL GAUGE
RATE METER
NEEDLE VALVE
DRY GAS METER
WET TEST METER
PUMP
AIR OUTLET
WATER OUT
SURGE TANK
LEVEL ADJUST

Figure 4-13. Dry Gas Meter Calibration System

the calibration results (Y_i) vary by no more than 2 percent. The average Y_i is then calculated and recorded on the face of the DGM console. An example DGM calibration data sheet is presented in Figure 4-14 and a post-test calibration check form is shown in Figure 4-15.

During this project, Rockwell dry gas meters will be used during the SASS, Modified Method 5, and Method 5 tests. The Modified Method 5 and Method 5 DGM calibrations will be performed at Radian's Austin, Texas laboratory using an American Wet Test Meter as an intermediate standard. Using a five-foot American Bell Prover, the intermediate standard is calibrated annually by Carl Poe Co., Inc., in Houston, Texas. The bell jar is routinely calibrated and certified using a "strapping technique" that is traceable to an NBS reference standard. The SASS DGM calibrations will be performed by Fluid * Meter Service Corporation using a ten-foot American Bell Prover. *

A Singer Model DTM-115 low flow DGM will be used during the VOST testing. The Singer DGM calibrations will be performed using a GCA/Precision Scientific wet test meter that is accurate to 0.27 liters per minute. The calibration system and procedure for the Singer DGM is similar to the calibration used for the Rockwell DGM except the Singer DGM will be calibrated at a flowrate of 0.5 to 1.0 liter per minute.

4.5.1.6 Analytical Balance Calibration

During the field measurement program, the analytical balances will be calibrated over the expected range of use with standard weights (NBS Class S) on a daily basis. Measured values must agree within ±0.1 mg.

4.5.1.7 CEM Calibration

CEM calibration is discussed in Section 5.18.5.

Date ____________ Calibrated by ____________ Meter or Console No. ____________

Barometric pressure, P_b = ____________ in. Hg Wet Test Meter No. ____________

Test DGM Flow Rate (ACFM)	Orifice Setting (ΔH) (in. H_2O)	Gas Volumes (ft³)						Temperature °F								Elapsed Time (min) (θ)	Vacuum (2-4 in. Hg)
		Wet Test Meter			Dry Gas Meter			Wet Test Meter			Dry Gas Meter						
											Inlet		Outlet				
		Initial	Final	Delta (V_{std})	Initial	Final	Delta (V_{test})	Initial	Final	Ave (T_{std})	Initial	Final	Initial	Final	Ave (T_{test})		

Test DGM Flow Rate (ACFM)	Orifice Setting (ΔH)	$Y_i = \frac{V_{std}\,P_b\,(T_{test}+460)}{V_{test}\left(P_b+\frac{\Delta H}{13.6}\right)(T_{std}+460)}$	$\Delta H@_i = \frac{.0317\,\Delta H}{P_b\,(T_{test}+460)}\left[\frac{(T_{std}+460)\theta}{V_{std}}\right]^2$
Average		Y =	ΔH@ =

Figure 4-14. Dry Gas Meter Calibration Form

Method 5 Acceptance Criteria

1) $Y_i = Y \pm 0.02Y$
2) $\Delta H@_i = \Delta H@ \pm 0.15\ \Delta H@$ (recommended)
3) $\Delta H@ = 1.84 \pm 0.25$ (recommended)
4) Calibration vacuum maintained at 2-4 in. Hg

Date ____________ Calibrated by ________________ Meter or Console No. ________

Barometric pressure, P_b = __________ in. Hg. Wet Test Meter No. ____________

Test DGM Flow Rate (ACFM)	Orifice Setting (ΔH) (in. H_2O)	Gas Volumes (ft³)						Temperature °F								Elapsed Time (min) (θ)	Vacuum (2-4 in. Hg)
		Wet Test Meter			Dry Gas Meter			Wet Test Meter			Dry Gas Meter						
											Inlet		Outlet				
		Initial	Final	Delta (V_{std})	Initial	Final	Delta (V_{test})	Initial	Final	Ave (T_{std})	Initial	Final	Initial	Final	Ave (T_{test})		

Test DGM Flow Rate (ACFM)	Orifice Setting (ΔH)	$Y_i = \dfrac{V_{std}\,P_b\left(T_{test} + 460\right)}{V_{test}\left(P_b + \dfrac{\Delta H}{13.6}\right)\left(T_{std} + 460\right)}$
Average		Y =

Acceptance Criteria

1) Y = Pretest Y ± 5%

2) Vacuum maintained at ≥ highest vacuum encountered during most recent field testing.

3) Y_i = Y ± 0.02 Y

Figure 4-15. Dry Gas Meter Post-Test Calibration Check Form

4.6 Sample Custody

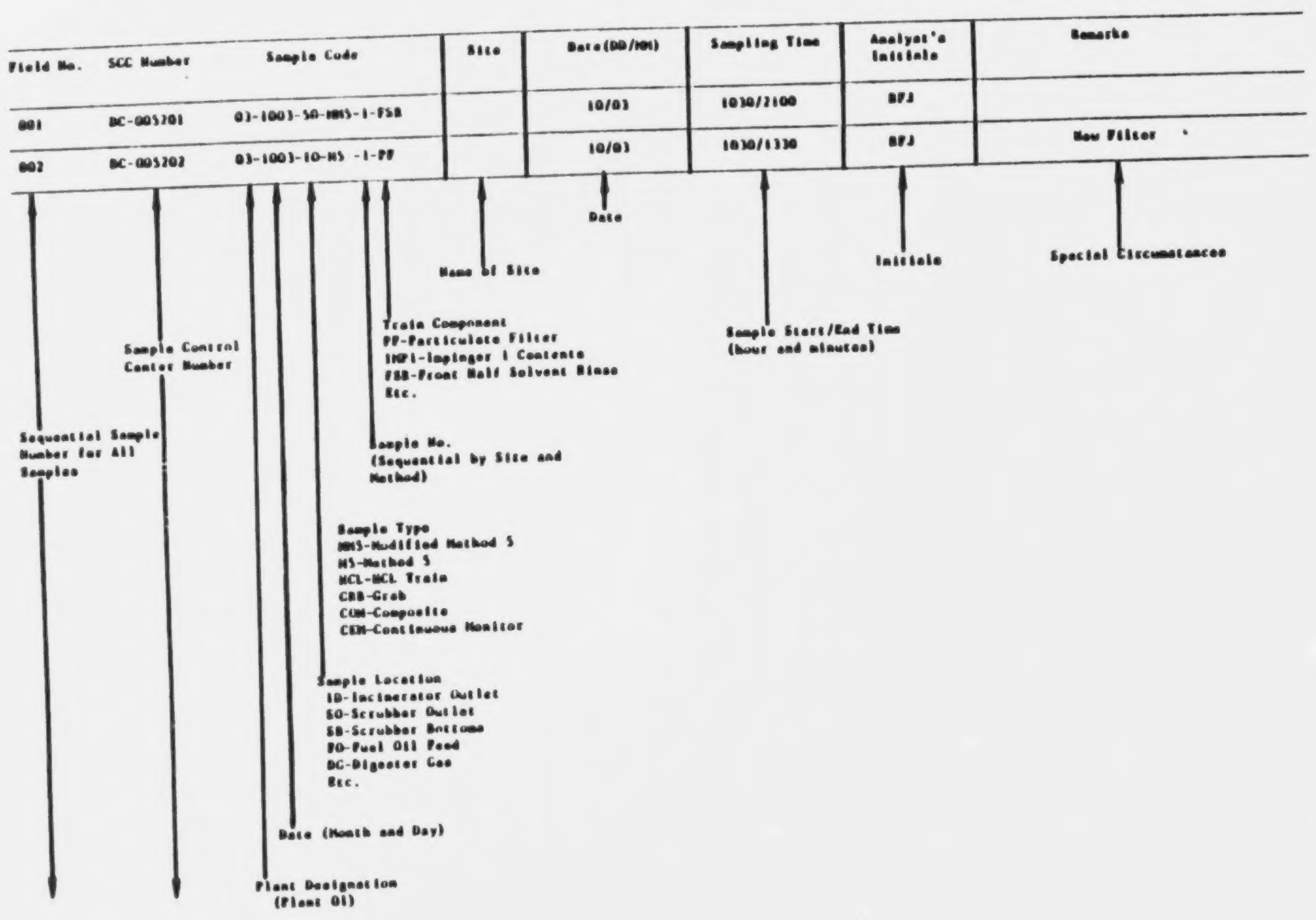
Sample custody procedures for this program are based on EPA recommended procedures. Since samples will be analyzed on site, at Radian's permanent laboratory facilities, and at Huffman Labs, the custody procedures discussed below will emphasize careful documentation of monitoring, sample collection, and field analytical data and the use of chain-of-custody records for samples being transported.

The field sampling leader will be responsible for ensuring that proper custody and documentation procedures are followed for the field sampling and field analytical efforts. He will be assisted in this effort by the sampling personnel involved in sample recovery.

All sampling data, including sampling times, locations, and any specific considerations associated with sample acquisition, will be recorded on preformatted data sheets. Following sample collection, all samples will be logged into a master logbook (bound notebook) and given a unique alphanumeric identification number. Any specific sample preservation, storage, or on-site analysis information will also be noted. An example master logbook format is shown in Figure 4-16. Sample labels (Figure 4-17) and chain-of-custody seals (Figure 4-18) will be completed and affixed to the sample container. Finally, chain-of-custody forms (Figure 4-19) will be completed by any personnel involved in the sampling handling.

Each shipment of samples to be analyzed by Huffman Labs will be given a batch number (#1, 3, 3, etc.). Shipping containers will be sealed using a chain-of-custody seal.

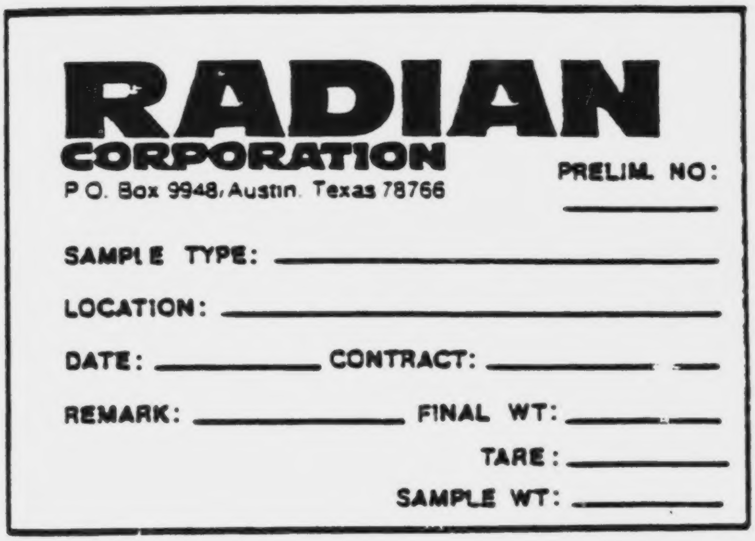
Samples will be shipped to Huffman Labs in ice chests and will be kept cool (approx. 4°C) with "blue ice" packs surrounding them. Transportation of the samples will be accomplished via overnight courier.



Field No.	SCC Number	Sample Code	Site	Date(DD/MM)	Sampling Time	Analyst's Initials	Remarks
001	DC-005201	03-1003-SO-MM5-1-FSB		10/03	1030/2100	BFJ	
002	DC-005202	03-1003-IO-M5 -1-PF		10/03	1030/1330	BFJ	New Filter

Sequential Sample Number for All Samples
Sample Control Center Number
Plant Designation (Plant 01)
Date (Month and Day)
Sample Location
IO-Incinerator Outlet
SO-Scrubber Outlet
SB-Scrubber Bottoms
FO-Fuel Oil Feed
DG-Digester Gas
Etc.
Sample Type
MM5-Modified Method 5
M5-Method 5
HCL-HCL Train
GRB-Grab
COM-Composite
CEM-Continuous Monitor
Sample No. (Sequential by Site and Method)
Train Component
PF-Particulate Filter
IMP1-Impinger 1 Contents
FSB-Front Half Solvent Rinse
Etc.
Name of Site
Date
Sample Start/End Time (hour and minutes)
Initials
Special Circumstances

Figure 4-16. Example of Radian Master Logbook Format



RADIAN
CORPORATION
P.O. Box 9948, Austin, Texas 78766

PRELIM. NO: ____________

SAMPLE TYPE: ____________________________

LOCATION: ______________________________

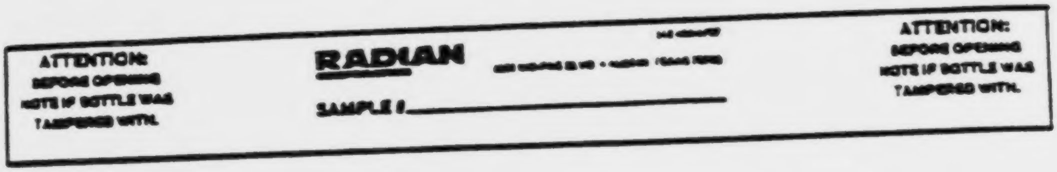
DATE: __________ CONTRACT: ____________

REMARK: ____________ FINAL WT: __________

TARE: __________

SAMPLE WT: __________

Figure 4-17. Example of Radian Sample Label



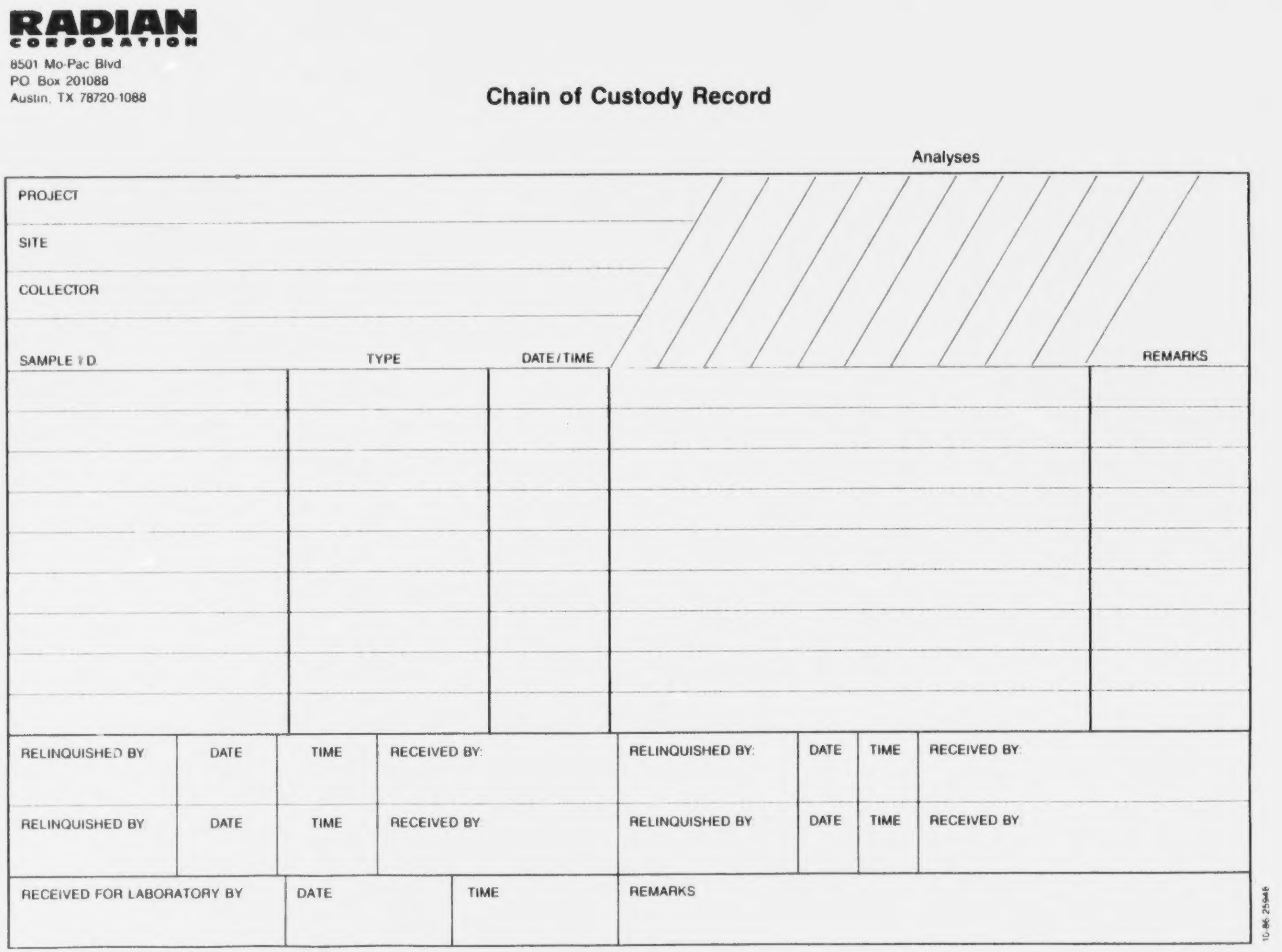
ATTENTION:
BEFORE OPENING
NOTE IF BOTTLE WAS
TAMPERED WITH.

RADIAN

SAMPLE #

ATTENTION:
BEFORE OPENING
NOTE IF BOTTLE WAS
TAMPERED WITH.

Figure 4-18. Example of Radian Chain-of-Custody Seal.



RADIAN
CORPORATION
8501 Mo-Pac Blvd
PO Box 201088
Austin, TX 78720-1088

Chain of Custody Record

PROJECT

SITE

COLLECTOR

SAMPLE I D	TYPE	DATE/TIME	Analyses	REMARKS

RELINQUISHED BY	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
RELINQUISHED BY	DATE	TIME	RECEIVED BY	RELINQUISHED BY	DATE	TIME	RECEIVED BY

RECEIVED FOR LABORATORY BY	DATE	TIME	REMARKS

10-86 25946

Figure 4-19. Example of Radian Chain-of-Custody Report Form.

Mary Dunlap will serve as the sample custodian for the samples sent to Huffman Laboratories. She will track the samples from receipt through analyses by a computerized chain-of-custody program developed for Huffman Labs.

5.0 LABORATORY PROCEDURES/CALIBRATIONS/QUALITY CONTROL

Samples of solid waste feed, scrubber effluent liquid, scrubber solids, scrubber water inlet, furnace ash, stack gases, and ambient air will be analyzed for parameters as specified in Table 4-1. The analytical scheme is discussed briefly below. Descriptions of the analytical methods are presented in the following sections.

Solid Streams Analysis

Solid streams including solid waste feed, furnace ash, and scrubber solids will be analyzed for PCBs, PCDD/PCDF, metals, V-PP+10 (volatile priority pollutants +10 next highest peaks), SV-PP+10 (semivolatile priority pollutants +10 next highest peaks), TCLP, EP Toxicity (metals), chlorine, moisture, ash, higher heating value, and ultimate analysis. All stream parameters will be measured in triplicate plus one duplicate collected concurrently with one of the replicate samples.

Liquid Streams Analysis

The scrubber water samples including scrubber liquid effluent and scrubber water inlet will be analyzed for PCB, PCDD/PCDF, pH, chlorine, metals, V-PP+10, SV-PP+10, total organic carbon, total suspended solids, and total dissolved solids. The scrubber effluent liquid will also be analyzed for TCLP and EP Toxicity (metals). Test parameters will be determined in triplicate plus the analysis of one duplicate sample.

Stack Gas Analysis

Stack gases will be analyzed using continuous emission monitoring systems (CEMs) for carbon monoxide, carbon dioxide, oxygen, nitrogen oxides, and total hydrocarbons. Grab samples will also be collected during each test run and analyzed for carbon dioxide and oxygen using an Orsat analyzer (EPA Method 3). Three Method 5 samples plus one duplicate sample will be collected for analysis of particulate matter, moisture, flow rate, and HCl.

Three integrated sets of VOST samples and one duplicate set will be collected for analysis of V-PP+10. Six (6) VOST tube pairs and two condensate vials will be collected for each VOST sample, for a total of 24 tube pairs and 8 condensate vials. Three analyses will result from each set of six VOST tube pairs collected and one condensate vial will be analyzed.

Three Modified Method 5 (MM5) samples and one duplicate will be collected for analysis of soluble chrome.

Three SASS samples plus one duplicate will be collected and analyzed for PCBs. *
In addition, three SASS samples plus one duplicate will be collected and *
analyzed for PCDD/PCDF and SV-PP+10. *

Ambient Air *

Ambient air samples will be collected daily upwind and downwind of *
the incineration system using a PUF (polyurethane foam) sampler. PUF samples *
will be analyzed for PCBs. *

5.1 Analytical Quality Control Procedures

For each measurement parameter, internal QC procedures are designed to control and assess the performance of the analytical system. The procedures include adherence to accepted laboratory procedures in accordance with the specified analytical protocols, the use of quality control charts, and adherence to acceptance criteria for internal QC sample analyses. A control chart consists of a graphical chart with the vertical scale plotted in units of the test result and the horizontal scale in units of time or sequence of results. The upper and lower control limits shown on the chart are used as criteria for action, or for judging the significance of variations between duplicate samples. Daily precision and accuracy data will be plotted by means of these quality control charts to determine if valid, questionable, or invalid data are being generated from day to day.

Internal QC procedures are described in the following sections for each analytical method and are summarized in Table 5-1. The preservation requirements and holding times for the samples taken during the test are shown in Table 5-2.

The internal QC procedures summarized in Table 5-1 are designed to ensure that the analytical systems remain properly calibrated, free from contamination, and in control. Analyses may not proceed until specific acceptance criteria for calibration, control sample recovery, and blank sample analyses are met. Measurement accuracy for project samples will be determined from matrix spike recoveries. If a matrix spike recovery is unacceptable, a control sample will be analyzed to determine whether the error is due to a problem with the analytical system or due to matrix effects. If the problem is related to the analytical system, the cause of the error will be corrected before analyses proceed; analyses will be repeated to the last acceptable control sample. When matrix spike recovery data indicate that accuracy objectives cannot be met due to matrix interferences, the data will be flagged, and the Project Director will be advised. The feasibility of alternate methods of quantitation (e.g., the method of standard additions) as a means of mitigating the matrix effects will be investigated with the client.

Duplicate sample analyses will be performed at a rate of one in 10 samples, as a minimum, for each parameter and each matrix. At least one sample will be analyzed in duplicate for each parameter and each matrix if there are fewer than 10 samples. As a minimum, matrix spikes with the target parameter shall be performed at a rate of one in 10 samples for each parameter and each matrix. If there are fewer than 10 samples, at least one matrix spike with the compound of interest shall be analyzed for each matrix.

Acceptance criteria for control sample analyses and drift checks will also be used to control analytical variability, although precision estimates will be based on replicate measurements of the same parameter in actual field samples. Control sample recoveries will be required to repeat within specified limits or analyses will not proceed. If duplicate analysis

TABLE 5-1. SUMMARY OF ANALYTICAL QUALITY CONTROL CHECKS, FREQUENCIES, ACCEPTABLE CRITERIA, AND CORRECTIVE ACTION

Parameter/Method	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
GC/MS Analyses	Linearity Check (multipoint calibration)	Once prior to sample analysis	Correlation coefficient ≥ 0.90	(1) Repeat linearity check. (2) If still unacceptable, make necessary adjustments. (3) Repeat linearity check.
	Single point check	Daily (at end of analyses)	Agreement with 15% of value predicted from multipoint calibration curve	(1) Repeat single point check. (2) If still unacceptable, perform new multipoint calibration.
	Surrogate spike analysis	Every sample	Agreement within $\pm 50\%$ of theoretical value	(1) Repeat extraction and analysis. (2) Flag data.
	Duplicate Analysis	10% of Samples	Agreement of analyses within 20% cr	(1) Obtain third value.
Metals (ICP, AA) GFAA and CVAA	Linearity check	Daily (prior to testing)	Correlation coefficient ≥ 0.9950	(1) Repeat linearity check. (2) If still unacceptable, prepare fresh standards. (3) Repeat linearity check.
	Analytical blank	Daily (prior to testing)	Measured value < 3 times MDL	(1) Repeat blank analysis. (2) If necessary, determine source of contamination. (3) Contact lab manager.
	QC check sample	10% of samples	Agreement of analyses within 10% of theoretical value	(1) Repeat QC sample analysis. (2) If necessary, prepare a new calibration curve. (3) Reanalyze samples to last acceptable QC check.
	Duplicate analysis	10% of samples	Agreement of analyses within 20% (CV)	(1) Obtain third value.
	Spiked samples	10% of samples	Agreement within 25% of theoretical value	(1) Repeat test. (2) Analyze control sample for analyte of interest. (3) Flag Data - contact Project Director.
HCl (Acid Train/ Ion Chromatograph)	Linearity check (multipoint calibration)	Twice (prior to and upon completion of analyses)	Correlation coefficient ≥ 0.9950 and slope within 10% of running mean for previous six determinations	(1) Repeat linearity check. (2) Prepare new standards. (3) Service instrument.
	Duplicate sample analysis	20% of samples	Agreement of analyses within 10% CV	(1) Repeat analyses.

TABLE 5-2. PRESERVATION REQUIREMENTS AND HOLDING TIMES FOR SAMPLES

Parameter	Preservation and Storage Requirements	Maximum Holding Time (Days)
pH	-----	6 Hours
EP, TCLP (aqueous)	4°, pH <2 (HNO_3)	38
EP, TCLP (non-aqueous)	4°C	ASAP
Chloride	None	28
Ultimate	None	None
Ash, Moisture	None	None
HHV	None	None
TOC	4°C; pH <2 (H_2SO_4)	24 Hours
Solids (TSS, TDS)	4°C	7
Particulate Matter	None	None
Moisture	None	None
Metals		
Liquid-Dissolved	Filter, <2 (HNO_3)	6 Months
Solids	None	6 Months
Soluble Chromium	4°C	ASAP
PCB	4°C	14 (extract), 30 (analyze)
PCDD/PCDF	4°C	14 (extract), 30 (analyze)
Volatile and Semi-Volatile Organics		
8240	4°C, Dark, Inverted	14
8270	4°C	14 (extract), 30 (analyze)
SASS (PCB, PCDD/PCDF, SV-PP+10)	4°C	14 (extract), 30 (analyze) *
VOST	4°C	Not specified in Protocol; will analyze within 14 days

results do not agree within the specified acceptance criteria, a third value will be obtained to improve the estimate for precision for that parameter.

In addition to controlling the quality of data during production, internal QC sample test results will be used to provide estimates of precision and accuracy which will be used in the evaluation and interpretation of project data.

5.2 V-PP+10 Analysis

V-PP+10 analysis will be conducted on several types of samples, including solid, liquid, and gas phase samples. The solid and liquid incinerator samples include:

- Solid Waste Feed;
- Furnace Ash;
- Scrubber Effluent Liquid;
- Scrubber Water Inlet; and
- Scrubber Solids.

The gas phase samples include stack gas samples collected by VOST. V-PP+10 analysis of each type of sample will use the following techniques.

5.2.1 Stack Gases Analysis for V-PP+10

The VOST will be used to collect samples of the stack gases for quantitation of the V-PP+10. The VOST procedure includes the methodology for analysis of the collected tubes. Note that Method 8240 of SW-846, Appendix A is basically the same as EPA Method 624 with the difference between the methods being the surrogates used to measure sample recovery.

The VOST analytical technique involves the analysis of Tenax and Tenax-charcoal sampling traps by thermal desorption. A helium purge of the desorbed volatiles is bubbled through a water impinger and collected on a Method 624 analytical trap. Subsequently, this analytical trap is desorbed by the traditional Method 624 procedure and analyzed by GC/MS. The sampling traps are desorbed in a separate oven controlled at 190°C and the volatiles introduced to a standard Tekmar purging apparatus. The detection limit for the POHCs is approximately 25 ng per single analyzed tube.

Before analysis by GC/MS, all traps, including the blanks, are spiked with an internal standard of bromofluorobenzene (BFB) to a total of 150 ng per trap. Bromofluorobenzene was chosen, instead of perfluorobenzene, so that calibration of the mass spectrometer tuning was also possible. BFB is the tuning standard for Method 624. Addition of the internal standard is accomplished by connecting each trap to a gas chromatograph injection port maintained at 150°C. The oven of the GC is at room temperature. Helium flow through the trap is set at 50 cc/min, and a 1-uL aliquot of a 150 ng/uL methanol solution of bromofluorobenzene is injected using the solvent flush technique. After injection, the gas flow is maintained for 2 minutes, and then the trap is removed and analyzed immediately by GC/MS.

5.2.1.1 Calibration

Typical conditions used for the GC/MS analysis are presented in Table 5-3. The analytical procedure and instrument conditions are similar to those used in the volatile organic analysis procedure of Method 624. The GC/MS instrument is calibrated by spiking known concentrations of the compounds onto a Tenax trap. A multipoint calibration curve is initially established. Two-point checks of this calibration are made on a daily basis, and the internal standard, BFB, is monitored on each analysis. Not all organic compounds provide good linear response over a wide calibration range. For this reason, no analytical data outside of the calibration limits will be reported. If necessary, the calibration range will be extended to span the actual concentration.

TABLE 5-3. GC/MS ANALYTICAL CONSIDERATIONS FOR VOST TENAX® TRAPS

Instrument:	Finnigan 4000 Gas Chromatograph/Mass Spectrometer or equivalent
Data System:	INCOS Data System or equivalent
Column:	0.2% Carbowax® or Carbopack® C in a 2 mm I.D. x 6 ft glass tube
Temperature Program:	-10°C (10 minutes) to 190°C (15 minutes) at 10°C per minute
Injection Type:	Tekmar® switching valve
Source Temperature:	280°C
Injector Temperature:	190°C
Scan Range:	Low mass - 40, high mass - 450, rate 2 s/scan
Carrier Gas:	Helium @ 3 mL/min

5.2.1.2 Quality Control

Target analytes will be spiked onto the samples to measure recovery efficiency. Blank samples will be analyzed to monitor system contamination. Duplicate analysis will be performed at a 10% frequency to assess analytical variability.

5.2.2 Liquid and Solid Sample Analysis for V-PP+10

V-PP+10 compounds in liquid and solid samples will be analyzed using Method 8240 detailed in SW-846, "Test Methods for Evaluating Solid Waste" (3rd Edition). The methods detail the purge and trap procedure for preparing field samples for GC/MS analysis. Table 5-4 presents the volatile compounds analyzed by Method 8240.

A purge and trap procedure is used to remove the volatile organics from the field sample matrix and collect the volatiles on a sorbent cartridge. An inert gas is bubbled through the solution at ambient temperature and the volatile components are efficiently transferred from the aqueous phase to the vapor phase. The vapor is passed through a sorbent column which traps the volatiles. The volatiles are then thermally desorbed onto a packed GC column for analysis. Due to the disparity in purging efficiencies for various volatile compounds, recovery checks must be made to compensate for incomplete sparging of each compound. Solubility characteristics of the individual compounds are the major factor in determining purging efficiencies. While liquid samples are directly injected into the purge and trap system, solid samples are dispersed in methanol to dissolve the volatile organic constituents. A portion of the methanolic solution is combined with water for a specially designed purging chamber, then analyzed by purge and trap GC/MS following the normal liquid method.

5.2.2.1 Calibration

Before analysis, the GC/MS is tuned with 4-bromofluorobenzene (BFB) to give an acceptable mass spectrum as shown in Table 5-5. After meeting the

TABLE 5-4. COMPOUNDS FOR METHOD 8240 ANALYSIS

Compound	Instrument Detection Limit (ng)	Method Detection Limit (ug/L)
Chloromethane	10	2
Bromomethane	10	2
Dichlorofluoromethane	10	2
Vinyl chloride	10	2
Acetonitrile	50	10
Chloroethane	10	2
Iodomethane	10	2
Methylene chloride	10	2
Acrolein	500	100
Acetone	10	2
Acrylonitrile	50	10
Carbon disulfide	10	2
Trichlorofluoromethane	10	2
1,1-Dichloroethane	10	2
1,1-Dichloroethane	10	2
1,2-Dichloroethylene	10	2
Chloroform	10	2
Dichloroethane-d (I.S.)[a]	NA[b]	NA
Methyl ethyl ketone (MEK)	10	2
1,2-Dichloroethane	10	2
Dibromomethane	10	2
1-Chloro-2,3-epoxypropane (epichlorohydrin)	50	10
1,1,1-Trichloroethane	10	2
Carbon tetrachloride	10	2

(Continued)

TABLE 5-4. (Continued)

Compound	Instrument Detection Limit (ng)	Method Detection Limit (ug/L)
Vinyl acetate	10	2
Bromodichloromethane	10	2
Crotonaldehyde	500	100
1,2-Dichloropropane	25	5
trans-1,3-Dichloropropene	25	5
Trichloroethylene	10	2
Benzene-d_6 (I.S.)	NA	NA
1,3-Dichloropropane	10	2
Benzene	10	2
Chlorodibromomethane	10	2
cis-1,3-dichloropropene	25	5
1,1,2-Trichloroethane	10	2
1,2-Dibromoethane	10	2
2-Chloroethyl-vinyl ether	10	2
Methyl methacrylate	10	2
Trichloromethane	10	2
1,1,1,2-Tetrachloroethane	10	2
4-Methyl-2-pentanone (MIBK)	10	2
2-Hexanone	10	2
1,2,3-Trichloropropene	25	5
1,1,2,2-Tetrachloroethane	10	2
Toluene-d_8 (I.S.)	NA	NA
Ethyl methacrylate	10	2
Toluene	10	2
Chlorobenzene	10	2
Ethyl benzene-d_5 (I.S.)	NA	NA

[a] (I.S.) Designates an internal standard.

[b] NA = Not applicable.

TABLE 5-5. BFB KEY ION ABUNDANCE CRITERIA

Mass	Ion Abundance Criteria
50	15 to 40% of mass 95
75	30 to 60% of mass 95
95	Base Peak, 100% Relative Abundance
96	5 to 9% of mass 95
173	Less than 2% of mass 174
174	Greater than 50% of mass 95
175	5 to 9% of mass 174
176	Greater than 95%, but less than 101% of mass 174
177	5 to 9% of mass 176

tuning criteria, a five-point calibration curve will be generated according to method protocol. Response factors for the volatile compounds obtained from the five-point average will be used for quantitation.

Response factors will be calculated by tabulating the area response of the primary characteristic ions against the concentration for each compound, including the internal standards. The response factor obtained for the calibration standards analyzed immediately before and after a set of samples will be within ±20% of the response factor used for the quantification of the sample concentrations.

5.2.2.2 Quality Control

As a quality assurance function, surrogate standards (D_8-toluene, 4-bromofluorobenzene, and D_4-1,2-dichloroethane) will be spiked into the samples to measure recovery efficiency. A surrogate solution concentration of 250 ug/10mL in methanol will be prepared. Each sample will be spiked with 10 uL of the surrogate solution prior to analysis. Internal standards of bromochloromethane, 1,4-difluorobenzene, and D_5-chlorobenzene will be used. Matrix spiking standards will be prepared from volatile organic compounds which will be representative of the compounds being analyzed. Blank samples and duplicate analysis will also be performed.

5.3 SV-PP+10 Analysis

SV-PP+10 analysis will be conducted on all sampled streams including:

- Solid Waste Feed;
- Furnace Ash;
- Scrubber Effluent Liquid;
- Scrubber Water Inlet;
- Scrubber Solids; and
- Stack Gases.

5.3.1 Stack Gases Analysis for SV-PP+10 Analysis

SV-PP+10 analysis will be performed on the stack gas samples col-
lected using the SASS. The solid (XAD-2 resin) and liquid samples (aqueous *
condensate) will be prepared for analysis and then analyzed for semivolatile
constituents using the procedures outlined in SW-846, "Test Methods for
Evaluating Solid Waste," and in the EPA publication, "Methods for Organic
Chemical Analysis of Municipal and Industrial Wastewater." The SV-PP+10 in
the stack gas samples will be analyzed using the procedures specified in the
3rd edition of SW-846 Method 8270 and EPA Method 625 operated in the scanning
mode. Peaks greater than 10 percent of the total 10A current will be quan-
titated.

Note that SV-PP+10 and PCDD/PCDF will be analyzed in the same SASS *
sample. Surrogates applicable to both analyses will be injected into the *
samples prior to extraction. SV-PP+10 analysis will be completed prior to *
initiation of clean-up steps for the PCDD/PCDF analysis. *

The SASS aqueous condensates will be extracted using SW-846 Method *
3520, which is a continuous liquid-liquid extraction. The XAD-2 resin and *
filter catch of the SASS train will be extracted by Soxhlet extraction in *
accordance with SW-846 Method 3540. Methylene chloride will be the extraction
solvent. One-half of the sample extracts will be combined and concentrated
for analysis using a Kuderna-Danish concentration with Snyder columns. Final
solvent extract volume will be no less than one milliliter.

The extracts are analyzed by injection into a fused-silica, SE54 coated capillary GC column. The sample is thermally desorbed using hydrogen as the carrier gas. Electron impact ionization at 70 eV is used to produce mass spectra. The target detection limit is approximately 1 ug/g for samples containing 1 mg/g or less of extractable material. The detection limit are proportionately higher for more concentrated samples.

5.3.1.1 Calibration

An internal standard calibration procedure is used with D_4-1,4-dichlorobenzene, D_8-naphthalene, D_{10}-acenaphthene, D_{10}-phenanthrene, D_{12}-chrysene, and D_{12}-perylene. The internal standard is added to all calibration standards and all sample extracts analyzed by GC/MS. Standards for retention time and column performance will be applied as required by method protocol. One uL of each calibration standard is analyzed and results are used to calculate a response factor. The response factor will be verified each working day by the measurement of two or more calibration standards.

A methylene chloride solution containing 50 ng/ul of decafluorotriphenylphosphine (DFTPP) is used as the tuning standard. In order to verify injection port inertness and GC column performance, the standard will also contain 50 ng/ul each of 4,4'-DDT, penetachlorophenol, and benzidine. The GC/MS will be tuned each day of use by injecting this standard solution into the system. DFTPP is also included in the internal standard solution added to all samples and calibration solutions. DFTPP ion abundance criteria are given in Table 5-6.

5.3.1.2 Quality Control

Surrogate standards (D_6-phenol, 2-fluorophenol, 2,4,6-tribromophenol, D_5-nitrobenzene), will be added to each XAD-2 subsample to assess extraction efficiency. A field blank of the SASS will be collected and analyzed to monitor system contamination. The SASS field blank will be prepared by assembling the SASS train as for sample collection. The train will then be recovered and analyzed in the same fashion as a sample except that no gas will have been sampled. The field blank will be analyzed for SV-PP+10 and PCDD/PCDF as will samples. Duplicate analysis will be performed at a 10% frequency to assess analytical variability.

To simulate a matrix spike, a blank sample will be prepared. The *
blank sample will consist of XAD-2, methanol/methylene chloride, a filter, and *

an aqueous condensate, i.e. HPLC water. The matrix spike solution will be a mid-range calibration standard and will be added to the XAD-2 prior to extraction. * * *

5.3.2 Liquid and Solid Sample Analysis for SV-PP+10

Samples of the solid waste feed, scrubber effluent liquid, scrubber water inlet, scrubber solids, and furnace ash will be analyzed by SW-846 Method 8270. Semivolatile compounds analyzed by Method 8270 are listed in Table 5-7. Liquid samples will be extracted using Method 3520, liquid extraction. Solid samples will be extracted using Method 3540, Soxhlet extraction. Extracts of liquid and solid samples will be analyzed for semivolatile organic contaminants using GC/MS.

5.3.2.1 Calibration

The calibration methods for Method 8270 will follow procedures described in Section 5.3.1.1.

5.3.2.2 Quality Control

Quality control measures will follow those outlined previously in Section 5.3.1.2.

5.4 PCB Analysis

EPA Method 680 will be used to analyze stack gas, ambient air, PUF samples, and solid and liquid samples for PCBs by GC/MS. When analyzing solids, liquids, or other types of extractable samples, the method of choice is generally gas chromatography (GC). The analysis is low in cost and provides a low detection limit. Identification by GC is accomplished by using identifiable patterns given off by the mixture of the various chlorinated

TABLE 5-6. DFTPP KEY IONS AND ION ABUNDANCE CRITERIA[a]

Mass	Ion Abundance Criteria
51	30 to 60% of mass 198
68	Less than 2% of mass 69
70	Less than 2% of mass 69
127	40 to 60% of mass 198
197	Less than 1% of mass 198
198	Base peak, 100% relative abundance
199	5 to 9% of mass 198
275	10 to 30% of mass 198
365	Greater than 1% of mass 198
441	Present but less than mass 443
442	Greater than 40% of mass 198
443	17 to 23% of mass 442

---

[a] Eichelberger, J.W., L.E. Harris, and W.L. Budde. Reference compound to calibrate ion abundance in gas chromatography-mass spectrometry. Analytical Chemistry, 47:995, 1975.

TABLE 5-7. COMPOUNDS FOR METHOD 8270 ANALYSIS[a]

Compound	Instrument Detection Limit (ng)	Method Detection Limit (ug/L)
N-Nitroso-dimethylamine	5	5
Pyridine	5	5
2-Methylpyridine (2-Picoline)	5	5
Fluorophenol (Surr.)[b]	NA[c]	NA
Methyl methane sulfonate	5	5
p-Benzoquinone	5	5
2-Fluoroaniline (Surr.)	NA	NA
Pentafluorophenol (Surr.)	NA	NA
Phenol-d_5 (I.S.)	NA	NA
Phenol-d_3 (Surr.)	NA	NA
Phenol	2	2
bis-(2-Chloroethyl)ether	2	2
2-Chlorophenol	2	2
1,3-Dichlorobenzene	2	2
Benzyl chloride	2	2
1,4-Dichlorobenzene	2	2
1,2-Dichlorobenzene	2	2
bis-(2-Chloroisopropyl) ether	2	2
N-Nitroso-pyrrolidine	5	5
Acetophenone	2	2
N-Nitrosodi-n-propylamine	2	2
2-Methyl aniline (o-Toluidine)	5	5
Hexachloroethane	2	2
Nitrobenzene	2	2

(Continued)

TABLE 5-7. (Continued)

Compound	Instrument Detection Limit (ng)	Method Detection Limit (ug/L)
Nitrobenzene-d_5 (Surr.)	NA	NA
N-Nitrosoiperidine	5	5
Isophorone	2	2
Decafluorobiphenyl (Surr.)	NA	NA
2-Nitrophenol	5	5
2,4-Dimethyl phenol	2	2
4-Nitrophenol	25	25
Bis-(2-Chloroethoxy) methane	2	2
2,4-Dichlorophenol	2	2
1,2,4-Trichlorobenzene	2	2
Napthalene-d_8 (I.S.)	NA	NA
Naphthalene	2	2
Resorcinol	10	10
2,6-Dichlorophenol	5	5
Hexachloropropene	10	10
Hexachlorobutadiene	2	2
1,2,3-Trichlorobenzene	5	5
N-Nitro-N-butylamine	5	5
4-Chloro-m-cresol	2	2
Saffrole	5	5
2-Methylnaphthalene	ND[e]	ND
1,2,4,5-Tetrachlorobenzene	ND	ND
Hexachlorocyclopentadiene	5	5
2,4,6-Trichlorophenol (Surr.)	5	5

(Continued)

TABLE 5-7. (Continued)

Compound	Instrument Detection Limit (ng)	Method Detection Limit (ug/L)
2-Fluorobiphenyl (Surr.)	NA	NA
1-Chloronaphthalene	2	2
2-Chloronaphthalene	2	2
1,4-Naphthaquinone	5	5
Dimethyl phthalate	2	2
m-Dinitrobenzene	5	5
2,6-Dinitrotoluene	5	5
Acenaphthalene	2	2
Acenaphthene	2	2
2,4-Dinitrotoluene	5	5
Pentachlorobenzene	5	5
1-Naphthylamine	5	5
2,3,4,5-Tetrachlorophenol	10	10
2,3,5,6-Tetrachlorophenol	10	10
2,3,4,6-Tetrachlorophenol	10	10
Diethyl phthalate	2	2
4-Chlorophenyl phenyl ether	ND	ND
Fluorene	2	2
4,6-Dinitro-o-cresol	10	10
Thiurame	5	5
N-Nitroso-diphenylamine	5	5
1,2-Diphenylhydrazine	2	2
2,4,6-Tribromophenol (Surr.)	NA	NA
4-Bromophenyl phenyl ether	2	2

(Continued)

TABLE 5-7. (Continued)

Compound	Instrument Detection Limit (ng)	Method Detection Limit (ug/L)
Hexachlorobenzene	2	2
4-Aminobiphenyl	5	5
Pronamide	10	10
Pentachlorophenol	5	5
Benzidine	ND	ND
Pentachloronitrobenzene	5	5
Phenanthrene-d_{10} (I.S.)	NA	NA
Phenanthrene	2	2
Anthracene	2	2
Dibutyl phthalate	2	2
Fluoranthene	2	2
Pyrene-d_{10} (Surr.)	NA	NA
Pyrene	2	2
p-Terphenyl-d_{14} (Surr.)	NA	NA
p-Dimethylaminoazobenzene	5	5
Butyl benzyl phthalate	2	2
bis-(2-Ethylhexyl)phthalate	2	2
Benz(a)anthracene	2	2
Chrysene-d_{12} (I.S.)	NA	NA
Chrysene	2	2
Di-n-octyl phthalate	2	2
Benzo(b)fluoranthene	2	2
Benzo(k)fluoranthene	2	2
7,12-Dimethylbenz(a)anthracene	5	5

(Continued)

TABLE 5-7. (Continued)

Compound	Instrument Detection Limit (ng)	Method Detection Limit (ug/L)
Benzo(a)pyrene	2	2
Perylene-d_{12} (I.S.)	NA	NA
3-Methylcholanthrene	5	5
Dibenz(a,h)anthracene	ND	ND
Indeno(1,2,3-c,d)pyrene	2	2
Benzo(g,h,i)perylene	2	2
Dibenz(a,h)acridine	ND	ND

[a] Column conditions: 30 m DB-5 x 0.25 mm ID, 1.0 um film thickness with helium carrier gas at 30-40 cm/sec flow rate. Initial oven temperature 20°C for 0.5 minutes, and then ramp at 3°C/min to 320°C.

[b] (Surr.) designates a compound as a surrogate compound.

[c] "NA" means not applicable.

[d] (I.S.) designates a compound as an internal standard.

[e] "ND" means not determined.

isomers of each PCB. Quantitation is achieved by choosing three or more of the larger peaks and developing an average response factor for that particular PCB using the areas from these peaks.

Analysis of gas samples such as those collected at the exhaust stack is much more difficult. Since PCBs contain a variety of chlorinated biphenyls containing two to ten chlorines, the volatility and destruction efficiencies become much more critical. The analysis may be biased toward the more volatile fraction, usually those biphenyls containing two to six chlorines. The result is that a distinctive pattern for a certain PCB is not observed. With the other compounds present in the stack gas causing interference, it is virtually impossible to identify specific PCB isomers by GC analysis.

GC/MS analysis using selected ion monitoring is superior for PCB analysis of gas samples. This type of analysis monitors for ions indicative of biphenyls with two chlorines, three chlorines, etc. The results are usually quantitated chlorinated biphenylcongeners instead of by Aroclor number (1254, 1260, etc.) as is most common.

In this program, all PCB analysis will be determined by GC/MS.

5.4.1 Stack Gases Analysis for PCBs

Samples of the stack gases will be collected using a SASS train with XAD-2 as the adsorbent resin for PCB analysis. The sample is recovered using methanol and methylene chloride. The SASS train will provide three subsamples which will be extracted separately and the extracts combined for analysis. The three subsamples are: *
*

- The glass fiber filter,
- Methanol and Methylene Chloride rinses of the probe and filter holder, methylene chloride rinse of the condenser/resin trap including the XAD-2, * * *
- aqueous condensate.

All aqueous samples to be analyzed will be placed in a separatory funnel and extracted with hexane according to SW-846 Method 3520. The solid samples, the filter and XAD-2 will be Soxhlet with hexane extracted using SW-846 Method 3540. Sample extracts will then be combined, dried, and concentrated using a Kuderna-Danish evaporative flask fitted with a three-ball macro Snyder column. Final extract volume will be no less than one milliliter.

Sample extract components are separated with capillary column gas chromatography (GC) and identified and measured with low resolution, electron ionization mass spectrometry (MS). The recommended GC operating conditions are presented in Table 5-8. The mass spectrometer will be operated in the specific ion monitoring (SIM) mode.

5.4.1.1 Calibration

Two surrogate compounds are added to the XAD-2 subsample each sample *
before sample preparation; these compounds are $^{13}C_{12}$-4,4'DDT, *
$^{13}C_6$-gamma-BHC, $^{13}CF_{12}$-monochlorobiphenyl, $^{13}C_{12}$-tetrachlorobiphenyl, *
$^{13}C_{12}$-octachlorobiphenyl, and ^{13C}12-decachlorobiphenyl. Two internal *
standards, chrysene-d_{12} and phenanthrene-d_{10}, are added to each sample extract *
before GC/MS analysis and are used to calibrate MS response. Each concentration measurement is based on an integrated ion abundance of one characteristic ion.

As previously stated, PCBs will be identified and measured as congener groups (i.e., by level of chlorination). A concentration is measured for each PCB congener group. Total PCB concentration in each sample extract is obtained by summing congener group concentrations. Nine selected PCB congeners are used as calibration standards, and one internal standard, chrysene-d_{12}, is used to calibrate MS response to PCBs, unless sample conditions require the use of the second internal standard, phenanthrene-d_{10}.

TABLE 5-8. RECOMMENDED GC OPERATING CONDITIONS FOR PCB ANALYSIS

Column Type:	SE-54 or DB-5
Film Thickness:	0.25 um
Column Dimensions:	30 m x 0.32 mm
Helium Linear Velocity:	28-29 cm/sec at 250°C
Temperature Program for Splitless Injection:	
SIM Data Acquisition for PCBs (Analysis Time = Approx. 25 min)	Inject at 45°C and hold 1 min; increase at 20°/min to 150°C and hold 1 min; increase at 10°/min to 310°C.

Duplicate analysis will be performed at a 10% frequency to assess analytical variability.

5.4.2 Liquid and Solid, and Ambient Air Sample Analysis for PCBs *

EPA Method 680 will be followed for analysis of the solid waste feed, furnace ash, scrubber effluent liquid, scrubber water inlet, and scrubber solids, and the ambient air PUF plugs for PCBs. Solid samples and * PUF plugs will be Soxhlet extracted using Method 3540 and liquid/liquid extraction by Method 3520 will be used for extraction of liquid samples.

5.4.2.1 Calibration

The calibration methods for Method 680 have been described in Section 5.4.1.1.

5.4.2.2 Quality Control

Section 5.4.1.2 outlines quality control procedures for PCB analysis by Method 680.

5.5 PCDD and PCDF Analysis

All sampled streams will be analyzed for polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs).

5.5.1 Stack Gases Analysis for PCDD/PCDF *

Stack gas samples for analysis of PCDDs and PCDFs collected using a * SASS train will be analyzed according to Method 8280 of SW-846. PCDD/PCDF * analysis will be performed on the same SASS samples as SV-PP+10. *

The XAD-2 resin and filter will be Soxhlet extracted using Method * 3540 of SW-846. The aqueous condensate will be extracted by SW-846 Method * 3520 which is a continuous liquid-liquid extraction. The methanol/methylene * chloride and methylene chloride solvent rinses of the SASS train will be included in the extraction procedures. The solvent extracts of the SASS train will be combined and concentrated for analysis using a Kaderna-Danish concentrator with Snyder columns. The final extract volume will be no less than one milliliter.

PCDD/PCDF analysis by Method 8280 includes the extraction of samples with toluene in addition to methylene chloride. SASS samples for analysis of SV-PP+10 and PCDD/PCDF will be extracted with methylene chloride and then with toluene. The extracts will be quantitatively split. One-half of the methylene chloride extract will be used for SV-PP+10 analysis, and one-half of the methylene chloride extract and one-half of the toluene extract will be combined and analyzed for PCDD/PCDF. Surrogate spike quantities for both PCDD/PCDF and SV-PP+10 will be adjusted accordingly to account for the sample split.

The concentrated solvent extracts of the SASS train will be analyzed for PCDDs and PCDFs by Method 8280 of SW-846. The method uses a matrix-specific extraction, analyte-specific cleanup, and low resolution mass spectrometry techniques. The sensitivity of the method is dependent upon the level of interferents within a given matrix.

Method detection limits are based on analysis of soils and waters. The target analytical detection limit will be the lowest achievable within the constraints of matrix effects of individual SASS samples. The total detection limit for each of the PCDD/PCDF homologous series quantitated (tetra-, penta-, hexa-, hepta-, and octa-PCDD and PCDF) will be determined by multiplying the detection limit of a given isomer within that series by the number of peaks which can be resolved under the gas chromatographic conditions. The 2,3,7,8,x- isomers for each of the homolog groups will also be determined.

5.5.1.1 Calibration

Calibration of the analytical system will be initially accomplished by a five-point calibration performed in triplicate. The calibration mixture

will include at least one of each of the 2,3,7,8,x-tetra- through octa-isomers. The calibration results will be used to determine response factors
for the analytes versus the internal standard. The XAD-2 resin of the SASS *
samples will be spiked with the surrogate compounds *
$^{13}C_{12}$-2,3,7,8-tetrachlorodibenzodioxin and dibenzofuran, *
$^{13}C_{12}$-1,2,3,7,8-pentachlorodibenzodioxin and dibenzofuran, *
$^{13}C_{12}$-1,2,3,4,6,7,8-heptachlorodibenzodioxin and dibenzofuran, and *
$^{13}C_{12}$-octachlorodibenzodioxin and dibenzofuran to assess extraction *
efficiency.

The GC/MS will also be routinely calibrated using a check standard. The response of the check standard must fall within method acceptance limits or the five-point calibration must be repeated.

5.5.1.2 Quality Control

To simulate a matrix spike, a blank sample will be prepared. the *
blank sample will consist of XAD-2, methanol/methylene chloride, a filter, and *
an aqueous condensate, i.e. HPLC water. The matrix spike solution will be a *
mid-range calibration standard and will be added to the XAD-2 prior to *
extraction.

To evaluate system contamination, a field blank of the SASS will be *
prepared, recovered, and analyzed in the same fashion as samples. The SASS *
field blank will be prepared by assembling the SASS train as for sample *
collection. The train will then be recovered and analyzed in the same fashion *
as a sample except that no gas will have been sampled. *

Duplicate analysis will be performed at a 10% frequency to assess analytical variability.

5.5.2 Liquid and Solid Samples Analysis

The liquid and solid samples collected for PCDD/PCDF measurements *
will be analyzed using Method 8280 of SW-846. Aqueous samples will be *

extracted by continuous liquid-liquid extraction according to Method 3520 fo SW-846. Method 3540 which is a Soxhlet extraction technique will be used to extract solids. This method uses a matrix-specific extraction, analyte-specific cleanup, and low resolution mass spectrometry techniques. The sensitivity of this method is dependent upon the level of interferents within a given matrix. * *

Proposed quantification levels for target analytes will be 10 parts per billion (ppb) for solid samples and 10 parts per trillion (ppt) for liquid samples. The actual values will vary by individual isomer. The total detection limit for each of the PCDD/PCDF homologous series quantitated (tetra-, penta-, hexa-, hepta-, and octa-PCDD and PCDF) will be determined by multiplying the detection limit of a given isomer within that series by the number of peaks which can be resolved under the gas chromatographic conditions. The 2,3,7,8,x- isomers for each of the homolog groups will be determined.

5.5.2.1 Calibration

Calibration of the analytical system will be initially accomplished by a five-point calibration performed in triplicate. The calibration mixture will include at least one of each of the 2,3,7,8,x-tetra- through octa-isomers. The calibration results will be used to determine response factors for the analytes versus the internal standard. The XAD-2 resin of the SASS samples will be spiked with the surrogate compounds
$^{13}C_{12}$-2,3,7,8-tetrachlorodibenzodioxin and dibenzofuran,
$^{13}C_{12}$-1,2,3,7,8-pentachlorodibenzodioxin and dibenzofuran,
$^{13}C_{12}$-1,2,3,4,6,7,8-heptachlorodibenzodioxin and dibenzofuran, and
$^{13}C_{12}$-octachlorodibenzodioxin and dibenzofuran to assess extraction efficiency.

The GC/MS will also be routinely calibrated using a check standard. The response of the check standard must fall within method acceptance limits or the five-point calibration must be repeated.

5.5.2.2 Quality Control

Surrogate standards will be added to each sample to assess extraction efficiency. Blank samples will be analyzed to monitor system contamination. Duplicate analysis will be performed at a 10% frequency to assess analytical variability.

5.6 Metals

Samples of the stack gas particulate matter, solids, and liquids will be analyzed for metals by inductively coupled argon plasma emission spectroscopy (ICPES) using Method 6010 of "Test Methods for Evaluating Solid Wastes", SW-846, November 1986, 3rd Edition and by atomic absorption spectrosocopy (AAS) using Methods 7060, 7041, 4421, 7740, and 7470/7471 of SW-846. The solid samples and particulate matter collected on the filter of the Method 5 train will be solubilized using Method 3050 of SW-846. Prior to analysis liquid samples will be prepared by using Method 3020 from the same publication as the solid samples preparation. Lithium metaborate and sodium carbonate fusion techniques will also be used to recover silicon and boron.

The samples will be analyzed for a total of thirty-one (31) elements. A list of these elements, analytical technique, and analytical detection limits in the aqueous phase are shown in Table 5-9.

Inductively coupled argon plasma emission spectroscopy combines the multi-element capabilities of emission spectroscopy with the sensitivity of a high-temperature argon plasma source to provide a rapid, multi-elemental analysis which is comparable to graphite furnace atomic absorption spectroscopy for many elements. By way of a pneumatic nebulization system, samples are aspirated into the plasma. Atomic species in the aspirated droplets are excited and release photons of radiation of fixed wavelength dependent on the element of interest. This radiation is passed through an entrance slit and concentrated onto a grating which diffracts light into its component wavelengths. The intensity of the light at these wavelengths is measured by converting light to electrical energy.

Radian laboratories feature an Applied Research Model 34000B inductively coupled argon plasma emission vacuum spectrometer capable of analyzing up to forty elements simultaneously. The instrument is equipped with an autosampler, PDP 11-04 computer system, DEC VT100 CRT, and DEC Writer LA-36 printer. This system has a wavelength scanning entrance slit for performing off-peak background correction and a nebulizer tip desalter to permit analysis of samples containing high concentrations of dissolved solids.

The volatile elements (lead, arsenic, antimony, selenium, and mercury) will be analyzed by AAS. Arsenic, antimony, lead, and selenium are determined using graphite furnace techniques (SW-7060, 7041, 7421, and 7740, respectively).

Mercury is determined by the cold vapor technique (SW-7470/7471). Aqueous samples (Method 7470) are acidified prior to analysis. Solids are combusted in a Parr bomb where the mercury is sorbed into potassium permanganate. Hydroxylamine hydrochloride and stannous chloride are used to reduce the mercury to the metallic state. Then, air is bubbled through the solution and the entrained mercury is passed through the absorption cell of an AAS.

5.6.1 Calibration

Calibration procedures for GFAA, ICPES, and CVAA will include a blank and a minimum of three upscale standards. Linearity of the standards should yield a correlation coefficient (r) ≥ 0.9950.

TABLE 5-9. METHODS AND DETECTION LIMITS FOR METALS ANALYSIS[a]

Element	Comments	Detection Limit in Analyte (ug/mL)
Aluminum		0.050
Antimony	b	0.005
Arsenic	b,c	0.004
Barium	c	0.0006
Beryllium		0.0005
Boron		0.009
Cadmium	c	0.002
Calcium		0.045
Chromium	c,d	0.001
Cobalt		0.006
Copper		0.001
Iron		0.008
Lead	b,c	0.003
Lithium		0.0005
Magnesium		0.034
Manganese		0.0005
Mercury	c,e	0.0002
Molybdenum		0.002
Nickel		0.003
Phosphorus		0.18
Selenium	b,c	0.002
Silicon		0.016
Silver	c	0.002
Sodium		0.006
Strontium		0.0004
Sulfur		0.030
Thallium		0.091
Titanium		0.005
Vanadium		0.003
Zinc		0.003

[a] Analyzed by Inductively coupled argon plasma emission spectroscopy (ICPES) unless noted otherwise under Comments.

[b] Analyzed by Atomic Absorption Spectroscopy (AAS) utilizing graphite furnace techniques.

[c] RCRA characteristic of EP Toxicity contaminant.

[d] Total chromium.

[e] Analyzed by AAS utilizing the cold vapor technique.

5.6.2 Quality Control

Quality control procedures for metals analyses will include daily multipoint calibration, analysis of QC check samples, duplicate analyses, spiked sample analyses, and blank analyses. Acceptance criteria and corrective action are shown in Table 5-1.

5.7 Soluble Chromium

The stack gases will be sampled in accordance with the method described in Section 4.4.1.3. The resulting samples will be analyzed for soluble chromium (hexavalent chromium) using EPA Method 218.4. By this method, the hexavalent chromium is chelated using ammonium pyrrolidine dithiocarbamate. The chelated chromium is then extracted from the sample medium using methyl ethyl ketone. The solvent extract is then analyzed by flame atomic absorption spectroscopy.

The stability of hexavalent chromium is not completely understood, and the method recommends that chelation and extraction be carried out as soon as possible. The stack gas samples for soluble chromium analysis will be chelated and extracted on-site soon after sample collection.

5.7.1 Calibration

The atomic absorption spectrometer will be calibrated with a blank and three upscale hexavalent chromium standards. The blank and standards will be chelated and extracted in the same fashion as the samples.

5.7.2 Quality Control

Quality control procedures for the analysis will include multipoint calibration, analysis of QC samples, duplicate analyses, and analysis of blank 0.1 N NaOH.

5.8 EP Toxicity

All samples with the exception of scrubber water inlet and stack gas will be analyzed by the RCRA Characteristic of EP Toxicity. The method is prescribed in EPA SW-846 and involves the acidic extraction of solid samples followed by analysis of specific trace metals, pesticides, and herbicides. Liquid samples are analyzed directly. Due to the nature of the wastes to be incinerated, no pesticides or herbicides are expected to be present. The EP Toxicity analysis will be for trace metals only, specifically arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. The analytical methods for these metals are presented in Table 5-10.

5.8.1 Calibration

Calibration procedures for GFAA, ICP, and CVAA will include a blank and a minimum of three upscale standards. Linearity of the standards should yield a correlation coefficient (r) $\geq$0.9950.

5.8.2 Quality Control

Eight metals--arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver--will be analyzed in EP and TCLP extracts to determine if these metals exceed RCRA maximum contaminant levels. Quality control procedures for these analyses will include daily multipoint calibration, analysis of QC check samples, duplicate analyses, spiked sample analyses, and blank analyses. Acceptance criteria and corrective action are shown in Table 5-1.

The method of standard additions (MSA) is required for analysis of all EP extracts. Quality assurance requirements will include a minimum of one blank to be extracted for every 10 extractions that have been conducted in an extraction vessel to determine if memory effects from the extraction equipment are occurring.

The proposal is presented in Federal Register, Volume 51, No. 114, June 13, 1986. The TCLP protocol is described in 40 CFR Appendix II to Part 261. TCLP is applicable to the same eight metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), four insecticides, and two herbicides as the EP leaching test, but includes 38 additional compounds. The additional organic toxicants represent RCRA Appendix VIII compounds for which there exist promulgated or proposed drinking water standards. The TCLP proposed toxicity characteristic contaminants and regulatory levels are presented in Table 5-11.

5.9 Toxicity Characteristic Leaching Procedure

All samples with the exception of scrubber water inlet and stack gases will be analyzed by the RCRA Toxic Characteristic Leaching Procedure (TCLP). TCLP is proposed by EPA to expand the Toxicity Characteristic to include additional chemicals and to incorporate a new extraction procedure. Extraction for volatiles involves acidic extraction in a zero-headspace extractor which is rotated in an end-over-end fashion at 30±2 rpm. Extraction for metals and semivolatiles uses the same procedure except that it is done in a glass container rather than the zero-headspace. The metals will be analyzed as described for EP Toxicity. The organic contaminants will be analyzed using SW-846 GC/MS Methods 8240 and 8270.

5.9.1 Calibration

Calibration procedures described in Section 5.2.1.1 and 5.3.1.1 will be used for GC/MS Methods 8240 and 8270. Calibration for metals analysis will be as described in Section 5.6.1.

5.9.2 Quality Control

Quality assurance requirements for TCLP include a minimum of one blank for every 10 extractions that have been conducted in an extraction vessel to determine if memory effects from the extraction equipment are occurring.

All quality control measures described in the appropriate analytical methods will be followed. The method of standard addition will be used for each waste type if: (1) recovery of the compound from spiked splits of the TCLP extract is not between 50 and 150%, or (2) if the concentration of the constituent measured in the extract is within 20% of the appropriate regulatory threshold. If more than one extraction is being run on samples of the same waste, the method of standard addition need only be applied once and the percentage recoveries applied to the remainder of the extractions.

TCLP extracts will be analyzed within the following periods after generation: volatiles--14 days, semivolatiles--40 days, mercury--28 days, and other metals--180 days.

5.10 Subcontract Analysis

Huffman Laboratories will analyze the solid waste feed, furnace ash, and scrubber solids for chlorine, ash, and ultimate and the solid waste feed for higher heating value.

5.10.1 Chlorine Analysis

Total organic chlorine will be determined in the solid waste feed, furnace ash, and scrubber solids. This analysis will be conducted by Huffman Laboratories, Inc. A total of three possible analytical methods are used. First, because the chlorine concentration can vary considerably depending on the type of waste, the wastes are initially screened using a combustion/absorption/titration technique. The method used is ASTM E442-81. After screening, samples of high concentration are analyzed by combustion/absorption/precipitation as silver chloride. The method used is ASTM D808-81. If during screening the chloride concentration is found to be low, then ion chromatography is the method used for chloride analysis. Ion chromatography is conducted by ASTM D4327-84. The ion chromatography method requires that the sample being analyzed is an aqueous sample. Therefore, when organic liquid, sludge, or solid wastes are analyzed by ion chromatography, the samples must first be combusted using an oxygen bomb (ASTM D808); the combustion gases are absorbed in water and the resulting solution is analyzed by ion chromatography.

5.10.2 Ash Analysis

The ash content of the solid waste feed, furnace ash, and scrubber solids will be determined using ASTM method D482 or D3174. Both methods have basically the same approach. Method D482 is for petroleum products and Method D3174 is for coke or coal-related materials. The sample is ignited and, after burning, is ashed at 775°C in a muffle furnace. The residue is then weighed. Analysis will be performed by the subcontract lab, Huffman Laboratories, Inc.

5.10.3 Ultimate Analysis (C, H, O, S, N, Ash, Moisture)

The solid waste feed will be analyzed for elemental concentrations using Method A003 from "Sampling and Analysis Methods for Hazardous Waste Combustion" for ultimate analysis. The procedure involves the analysis of carbon, hydrogen, nitrogen, phosphorus, sulfur, and chlorine. Oxygen is determined by difference. Method A003 is a conglomerate of ASTM methods. ASTM Method D-3178 analyzes for carbon and hydrogen by burning the samples in a combustion system followed by fixation of the products of combustion in an absorption train for analysis. Nitrogen is analyzed by ASTM Method D3179. The nitrogen in the sample is converted to ammonium salts by destructive digestion. Ammonia is recovered and analyzed titrimetrically. Phosphorus is determined spectroscopically, according to D-2795. ASTM Method D-3177 is used to measure sulfur using bomb calorimetry. The recovered sulfur is precipitated as $BaSO_4$ and determined gravimetrically. Chlorine is determined by Method D-2361 or D-808.

5.10.4 Higher Heating Value Analysis

The higher heating value (HHV) of the solid waste feed fuel will be determined. The heating value is determined using a bomb calorimeter, according to ASTM Methods D240-73 for the liquid wastes and D2015-77 for the solid wastes. The HHV analysis will be conducted by Huffman Laboratories, Inc.

TABLE 5-10. ANALYTICAL METHODS FOR TOXICITY CHARACTERISTIC METALS

Metal	Digestion Method	Analytical Method	Technique
As	3020	7060	GFAA
Ba	6010	6010	ICP
Cd	6010	6010	ICP
Cr	6010	6010	ICP
Hg	7470	7470	CVAA
Pb	3020	7421	GFAA
Se	3020	7740	GFAA
Ag	6010	6010	ICP

GFAA - Graphite Furnace Atomic Absorption

ICP - Inductively Coupled Argon Plasma Emission Spectroscopy

CVAA - Cold Vapor Atomic Absorption

TABLE 5-11. PROPOSED TOXICITY CHARACTERISTIC CONTAMINANTS AND REGULATORY LEVELS

Contaminants	Regulatory Level (mg/L)
Acrylonitride	5.0
Arsenic	5.0
Barium	100
Benzene	0.07
bis-(2-Chloroethyl)ether	0.05
Cadmium	1.0
Carbon disulfide	14.4
Carbon tetrachloride	0.07
Chlordane	0.03
Chlorobenzene	1.4
Chloroform	0.07
Chromium	5.0
o-Cresol	10.0
m-Cresol	10.0
p-Cresol	10.0
2,4-D	1.4
1,2-Dichlorobenzene	4.3
1,4-Dichlorobenzene	10.8
1,2-Dichloroethane	0.40
1,2-Dichloroethylene	0.1
2,4-Dinitrotoluene	0.13
Endrin	0.003
Heptachlor (and its hydroxide)	0.001
Hexachlorobenzene	0.13
Hexachlorobutadiene	0.72
Hexachloroethane	4.3

(Continued)

TABLE 5-11. (Continued)

Contaminants	Regulatory Level (mg/1)
Isobutanol	36
Lead	5.0
Lindane	0.06
Mercury	0.2
Methoxychlor	1.4
Methylene chloride	8.6
Methyl ethyl ketone	7.2
Nitrobenzene	0.13
Pentachlorophenol	3.6
Phenol	14.4
Pyridine	5.0
Selenium	1.0
Silver	5.0
1,1,1,2-Tetrachloroethane	10.0
1,1,2,2-Tetrachloroethane	1.3
Tetrachloroethylene	0.1
2,3,4,6-Tetrachlorophenol	1.5
Toluene	14.4
Toxaphene	0.07
1,1,1-Trichloroethane	30
1,1,2-Trichloroethane	1.2
Trichloroethylene	0.07
2,4,5-Trichlorophenol	5.8
2,4,6-Trichlorophenol	0.30
2,4,5-TP (Silvex)	0.14
Vinyl Chloride	0.05

5.10.5 Calibration

Calibration procedures of any instruments necessary for the analysis to be performed by Huffman Laboratories will be per laboratory method SOP.

5.10.6 Quality Control

Quality control for samples sent to Huffman Laboratories will be achieved in a variety of ways. In house quality control measures will be relied upon for overall analytical quality. Blind duplicates will be sent for analysis and duplicate analysis will be requested for some samples.

5.11 TSS and TDS Analysis

The concentration of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) present in the Scrubber Effluent Liquid and Scrubber Water Inlet will be determined using gravimetric procedures specified in the EPA document "Methods for Chemical Analysis of Water and Wastes". TSS and TDS will be determined using Methods 160.1 and 160.2, respectively.

TSS is determined by filtering a known mass of the sample, drying the solids to a constant weight, and using the ratio of the solids mass-to-total sample mass to determine TSS. A drying temperature of $105^{\circ}C$ is used. TDS is determined by drying a known mass (volume) of the sample to a constant weight and using the ratio of the solids mass-to-total sample mass to determine TDS.

5.11.1 Calibration

A Mettler Model 4400 top-loader balance that is calibrated yearly by a manufacturer representative will be used to perform the TSS and TDS analysis. The calibration consists of the measurements of a standard set of weights ranging from 0.5 g to 4000 g.

5.11.2 Quality Control

TSS and TDS concentrations obtained by gravimetric methods will be verified by performing replicate analysis on 10% of the samples. A top loading balance, capable of weighing 0.01 g, should be used for each weighing. If necessary, an analytical balance capable of weighing to 0.1 mg will be used to quantify very low solids concentrations.

5.12 pH Analysis

The pH of the scrubber liquor samples will be determined using a portable pH meter and combination electrode with temperature compensation in accordance with EPA Method 150.1. After a sufficient volume of the scrubber liquor is purged through the sample tap, a sample of the scrubber liquor will be collected in a plastic or glass beaker. A portable pH meter and combination electrode will then be used to rapidly measure the pH of the slurry. A mercury thermometer will be used to measure the temperature of the slurry. Both pH and temperature measurements will be recorded on the process log sheet, and the data will be used to help characterize the conditions at which the scrubber system operated during the trial burn.

5.12.1 Calibration

The pH meter should be calibrated with two buffers. One buffer should be at pH 7 and the second should be chosen to cover the range of pH values expected. The temperature compensation control should be set to the buffer temperature.

5.12.2 Quality Control

Quality assurance should include maintaining electrodes properly, using a buffer not used for calibration as a quality control sample, and insuring that the temperature compensation control is set for sample temperature when the measurement is made.

5.13 Particulate Matter

Particulates will be measured in the stack gas gas using EPA Method 5. The acetone wash from the nozzle, probe liner, and glassware prior to the filter on the Method 5 sampling train will be evaporated and the mass determined using an analytical balance. The glass fiber filter will be removed from the Method 5 sampling train, desiccated, and weighed to determine the mass of particulate present on the filter. The weight of the filter and the evaporated wash are totaled and related to the volume of gas sampled to determine the particulate loading.

5.13.1 Calibrations

Prior to weighing, the analytical balance will be calibrated using a standard set of weights and a built-in internal calibration weight. The internal weight specifications are 100 g ±0.2 mg, adjusted to an apparent density of 8.0 g/cm^3 at an air density of 1200 mg/L.

5.13.2 Quality Control

Prior to sampling, each glass fiber filter will be equilibrated in a desiccator, weighed to determine its initial mass using an analytical balance, and then it will be packaged in a labeled, individual glass petri dish.

Handling of the filters will be performed in clean areas out of drafts. Tweezers will be used to transfer the filters at all times.

In weighing the filters, both prior to and after sampling, repeat weighings will be performed at ≥ six-hour intervals. Repeat weighings must agree within ±0.2 mg to be considered acceptable.

Blank determinations will be performed on each lot of acetone rinse solution. Blank residue must be ≤0.01 mg/g or 0.001% of the blank weight.

A field blank of the entire Method 5 train will be obtained, including filter and impinger blanks. The field blank will be prepared by assembling the train as though to collect a sample, but no gas will be pulled through the system. The train will be disassembled and the same procedures used for actual sample recovery will be followed to retrieve the blank.

5.14 Flue Gas Moisture

The moisture content of the gas streams will be determined using the technique specified in EPA Method 4. In this method, a gas sample is extracted at a constant rate from the source and moisture is removed from the sample stream by condensation. The amount of moisture removed is gravimetrically determined and compared to the volume of gas sampled.

Calibration and Quality Control

Each impinger will be weighed to the nearest 0.1 g before and after sampling. Any unusual conditions or occurrences will be noted with each set of samples taken.

5.15 HCl Determination

For the determination of HCl in the stack gas, samples of gas will be passed through a series of impingers immersed in an ice bath. The first two impingers will contain 200 mL of 0.1 N NaOH and will be the Greenburg-Smith type. Following the first two impingers are a dry, modified Greenburg-Smith impinger and an impinger containing a desiccant. The sample will be analyzed using a Dionex Model 2010 ion chromatograph or similar instrument following Method 27 from the "FGD Chemistry and Analytical Methods Handbook", Radian Corportion, Volume 2, July 1984. This procedure is presented in the Appendix. Calibrations and QA/QC activities from this method will also be followed. In this procedure, the ions in solution are separated on an ion exchange column and detected conductimetrically.

5.15.1 Calibrations

The ion chromatograph will be calibrated for each sample set analyzed. This is accomplished by introducing different concentrations of chloride into the instrument. Calibration standards are prepared from certified standards. A minimum of three concentrations of chloride will be used to generate a calibration curve by the method of least squares fit of data (linear regression). The calibration is considered acceptable if the correlation coefficient is greater than 0.9950.

5.15.2 Ion Chromatograph Quality Control

Quality control will be maintained by analyzing standards, blind duplicates, and QC samples. At least 10% of the samples will be analyzed in duplicate.

5.16 Carbon Dioxide

During the proposed sampling for HCl, the collection of CO_2 in the 0.1 N NaOH impinger is a consideration which must be addressed. Because the impinger solutions are caustic, CO_2 will also be removed from the stack gas. Thus, the metered sample gas volume will be low by the amount of CO_2 removed by the impinger solutions. To account for the CO_2 removal, the 0.1 N NaOH impinger solutions will be analyzed for carbonate. The carbonate will be measured on an Oceanography International Corp. Model 524-B carbon analyzer with IR detector using Method 44 from the "FGD Chemistry and Analytical Methods Handbook", Radian Corporation, Volume 2, July 1984. This procedure is presented in the Appendix. Calibrations and QA/QC activities from this method will be followed. Using the carbonate analytical values to determine the amount of CO_2 removed by the impingers, the meter sample gas volume will be corrected.

5.16.1 Calibration

A multipoint calibration curve will be generated for each set of samples. A correlation coefficient greater than 0.9950 will be required for analysis to continue.

5.16.2 Quality Control

A QC check sample will be analyzed before and after every 10 field samples analyzed. A method blank will be analyzed to ensure freedom from contamination. One in 10 field samples will be analyzed in duplicate to assess analytical precision.

5.17 Oxygen and Carbon Dioxide Analysis

Grab bag samples will be collected in the field according to EPA Method 3 for CO_2 and O_2. These samples will be analyzed within 3 hours of collection using an Orsat analyzer. The Orsat apparatus measures oxygen and carbon dioxide by selectively absorbing each gas in absorbing solutions.

5.17.1 Calibration

The Orsat is calibrated as received from the manufacturer using a certified gas mixture of O_2 and CO_2 or ambient air. This calibration is performed to verify proper operation of the unit. If the unit is not accurate within $\pm$2% of the calibration gas, then the absorbing solution(s) will be changed and the calibration repeated.

5.17.2 Quality Control

Repeated passes of the sample through each absorbing solution will be made until two consecutive readings are the same or differ by no more than 0.2% for CO_2 and O_2. The Orsat analyzer will be checked for leaks prior to and following these analyses.

*

5.18 CEMs of CO, CO_2, O_2, NO_x and THC

CEMs will be used during the trial burn program to continuously monitor the concentrations of CO, CO_2, O_2, NO_x, and THC of the stack gases. A * brief description of each of the gas phase monitors is provided below.

5.18.1 Carbon Monoxide Analysis

A Bendix Model 85-105CA analyzer will be used to measure CO concentrations in the stack gas. The instrument is a non-dispersive infrared (NDIR) analyzer which measures the concentration of CO by infrared absorption at a characteristic wavelength.

5.18.2 Carbon Dioxide Analysis

To measure the CO_2 concentration in the stack gas, an MSA Model 303 non-dispersive infrared (NDIR) analyzer will be used. This instrument measures the concentration of CO_2 by infrared absorption at a characteristic wavelength.

5.18.3 Oxygen Analysis

A Taylor Model 540A oxygen analyzer will be used to determine O_2 concentrations of the stack gas. The Taylor Model 540A measures oxygen concentrations on the basis of strong paramagnetic properties of O_2 compared to other compounds present in combustion gases. In the presence of a strong magnetic field, O_2 molecules become temporary magnets. The Taylor 540A determines the sample gas O_2 concentration by detecting the displacement torque of the sample gas on a test body in the presence of a magnetic field.

*

5.18.4 Nitrogen Oxides Analysis

A TECO Model 10 analyzer will be used for NO_x measurement. This *
instrument determines NO_x concentrations by converting all nitrogen oxides *
present in the sample to nitric oxide and then reacting the nitric oxide with *

ozone. The reaction produces a chemiluminescence proportional to the NO_x concentration in the sample. The chemiluminescence is measured using a high-sensitivity photomultiplier. * * *

5.18.5 Total Hydrocarbon Analysis

A Beckman Model 400A will be used to continuously measure the concentration of hydrocarbons present in the flue gas. The analyzer utilizes a hydrogen flame ionization detector. The sensor is a burner where a regulated flow of sample gas passes through a flame sustained by regulated flows of a fuel gas and air. Within the flame, the hydrocarbon components of the sample stream undergo a complex ionization that produces electrons and positive ions. Polarized electrodes collect these ions, causing current to flow through an electronic measuring circuit. The ionization current is proportional to the rate at which carbon atoms enter the burner and is, therefore, a measure of the concentration of hydrocarbons in the original sample.

5.18.6 CEMs Calibrations

Calibrations of all continuous monitors will be accomplished by introducing standard gases at the front end of the CEM sampling probe prior to and after daily sampling to allow for the assessment of any impact caused by the sample gas conditioning system, including the heat traced sample line, on the pollutants being monitored. Table 5-12 presents the calibration standard gases which will be used to calibrate the instruments. All instruments will undergo multipoint linearity checks (two points plus zero) bracketing the predicted sample values. These checks will be performed at the beginning and end of the sampling program. In all cases, the acceptance criterion for the linearity checks will be a correlation coefficient (r) of $\geq$ 0.9950. If this criterion is not met, the linearity check will be repeated (following instrument maintenance, if necessary) until $r \geq 0.9950$ is achieved.

An analytical blank and a single-point response factor (RF) standard will be analyzed daily prior to testing for all continuous monitors. The * *

TABLE 5-12. STANDARDS FOR CONTINUOUS MONITORS

Analytical Parameter	Standard	Source	Documentation
$CO/CO_2/O_2$ Quantitation	CO-5, 400 ppmv, N_2-Balance; CO_2-15%, N_2-Balance; O_2-12%, N_2-Balance; CO-200 ppmv, CO_2-5%, O_2-3%, N_2-Balance	Scott Specialty Gases	Certified*
NO_x Quantitation	NO-50 ppmv, N_2-balance NO-500 ppmv, N_2-balance	Scott Speciality Gases	Certified*
THC Quantitation	Hexane-50 ppmv, N_2-Balance; Hexane-5 ppmv, N2-Balance	Scott Specialty Gases	Certified*

* "Certified" standards are mixtures analyzed by the gas manufacturer with the analytical accuracy certified to be ± 2%. Analyses are referenced to NBS standard reference materials, if SRMs exist, or to gravimetric standards, which are gravimetrically traceable to NBS.

acceptance criterion for the single-point RF will be an RF agreement within 20% of the previous multipoint RF. If this criterion is not met, the multipoint RF check will be repeated. The acceptance criterion for the analytical blank will be ≤1% of the instrument span. Drift checks will be performed prior to any calibration or zero adjustment.

5.18.7 CEMs Quality Control

During the testing program, CEMs operation will include the following QC procedures.

A single-point drift check will be performed by analyzing the same standard used for the single-point RF determination at the end of each day of testing. The acceptance criterion for this analysis will be agreement within 10% of the single-point RF determination. If this criterion is not met, the end of testing RF and the initial single-point RF will be used to quantitate samples assuming a linear drift throughout the test day. Calibration requirements for the continuous monitors are shown in Table 5-13.

All calibration standards will be certified standards (±2% analytical accuracy). The precision of the continuous monitors are ±1-2% of full scale based on the manufacturer's specification. A microprocessor-based data acquisition and storage system (DART II®) will be used to collect, reduce, and store the output from the CEMs on magnetic disks. Strip chart recorders will be used as a backup data logging system.

TABLE 5-13 SUMMARY OF CONTINUOUS MONITOR CALIBRATION REQUIREMENTS

Parameter	Method of Analysis	Type of Calibration	Calibration Standards	Frequency	Acceptance Criteria
CO	Bendix Model 85-105CA (NDIR)	Multipoint (Zero plus 2 upscale)	CO and CO_2 in N_2	Once at site prior to testing	Correlation coefficient ≥ 0.9950
		Single point RF	CO and CO_2 in N_2	Daily (prior to testing)	Agreement within 20% of multipoint RF
		Analytical blank	Zero N_2	Daily (prior to testing)	Zero value ≤ 1% of span
		Single point drift check	CO and CO_2 in N_2	Daily (at conclusion of analysis)	RF agreement within 10% of RF for single point RF check
CO_2	MSA Model 303 (NDIR)	Same as CO	Same as CO	Same as CO	Same as CO
O_2	Taylor Model 540A (Paramagnetic)	Same as CO	O_2 in N_2	Same as CO	Same as CO
NO_x	TECO Model 10 (Chemiluminescence)	Same as CO	NO in N_2	Same as CO	Same as CO
THC	Beckman Model 400A (Flame Ionization)	Same as CO	Hexane in N_2	Same as CO	Same as CO

6.0 DATA REDUCTION, VALIDATION, AND REPORTING

The overall data reduction, validation, and reporting flow scheme for this project is presented in Figure 6-1. Details of data reduction, validation, and reporting are discussed in the remainder of this section.

6.1 Calculations

The following sections detail the calculations which will be performed for data preservation.

6.1.1 PCB, PCDD/PCDF, V-PP+10, SV-PP+10, and Metals Mass Emission Rate Calculations

The mass emission rates (ug/hr) for PCB, PCDD/PCDF, V-PP+10, SV-PP+10, and metals in the stack gas samples will be calculated as follows:

$$MER = (M_n)\ (Qsd)/V_d \times 60\ (min/hr)$$

where: M_n = mass of compound collected (ug)

Q_{sd} = dry volumetric flow rate at standard conditions (dscfm)

V_d = dry gas volume sampled at standard conditions (dscf)

6.1.2 Particulate Mass Emission Calculation

The mass emission rate (grains per dscf) will be determined for total particulates based on EPA Method 5 as follows:

$$C_s = (M_n)\ (0.001)\ (15.43)/(V_d)$$

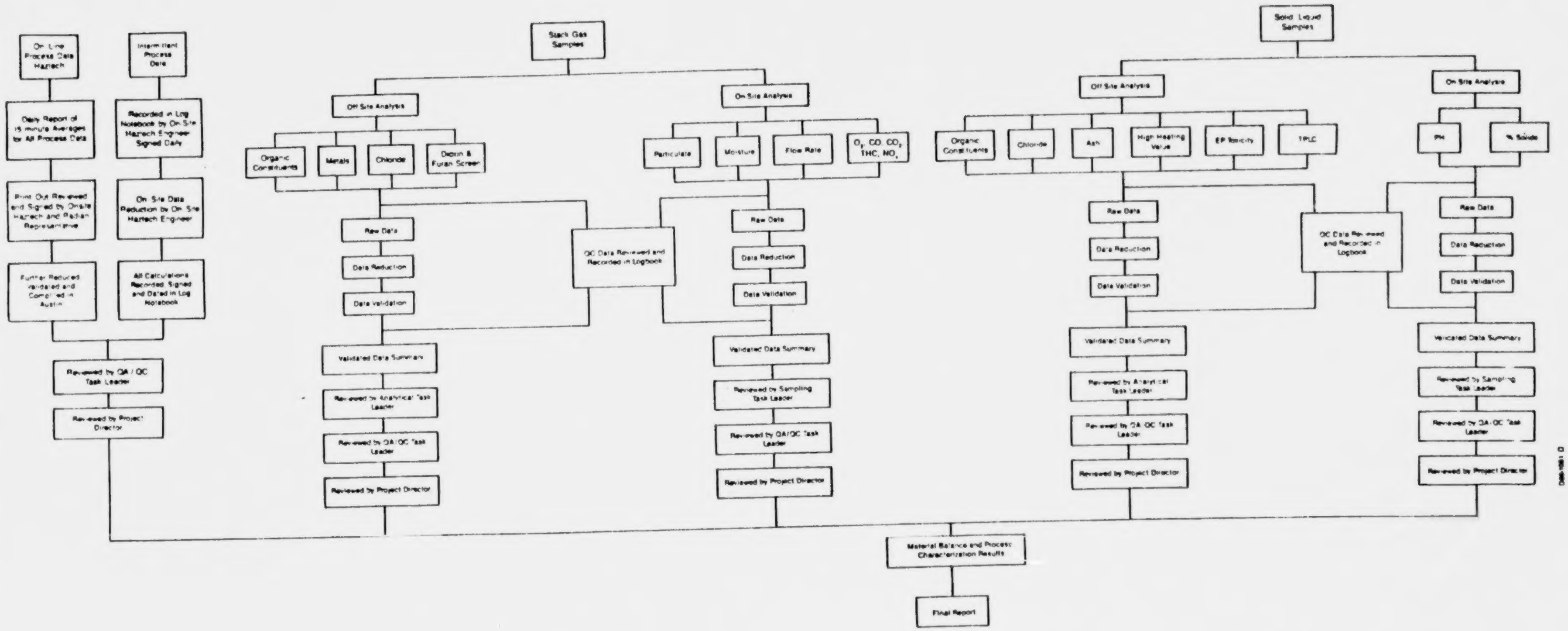

On Line Process Data Haztech
Daily Report of 15 minute Averages for All Process Data
Print Out Reviewed and Signed by Onsite Haztech and Radian Representative
Further Reduced Validated and Compiled in Austin
Intermittent Process Data
Recorded in Log Notebook by On-Site Haztech Engineer Signed Daily
On Site Data Reduction by On Site Haztech Engineer
All Calculations Recorded, Signed and Dated in Log Notebook
Reviewed by QA / QC Task Leader
Reviewed by Project Director
Stack Gas Samples
Off Site Analysis
Organic Constituents
Metals
Chloride
Dioxin & Furan Screen
Raw Data
Data Reduction
Data Validation
Validated Data Summary
Reviewed by Analytical Task Leader
Reviewed by QA/QC Task Leader
Reviewed by Project Director
QC Data Reviewed and Recorded in Logbook
On Site Analysis
Particulate
Moisture
Flow Rate
O_2, CO, CO_2, THC, NO_x
Raw Data
Data Reduction
Data Validation
Validated Data Summary
Reviewed by Sampling Task Leader
Reviewed by QA/QC Task Leader
Reviewed by Project Director
Solid Liquid Samples
Off Site Analysis
Organic Constituents
Chloride
Ash
High Heating Value
EP Toxicity
TPLC
Raw Data
Data Reduction
Data Validation
Validated Data Summary
Reviewed by Analytical Task Leader
Reviewed by QA/QC Task Leader
Reviewed by Project Director
QC Data Reviewed and Recorded in Logbook
On Site Analysis
PH
% Solids
Raw Data
Data Reduction
Data Validation
Validated Data Summary
Reviewed by Sampling Task Leader
Reviewed by QA/QC Task Leader
Reviewed by Project Director
Material Balance and Process Characterization Results
Final Report

Figure 6-1. Overall Data Reduction, Validation, and Reporting Flow Scheme for the Shirco Incinerator Unit Trial Burn at Brandon, Florida
]

where: C_s = concentration of particulates in the flue gas at dry standard conditions (grains/dscf),

M_n = mass of specie collected (mg),

V_d = dry gas volume sampled at standard conditions (dscf),

0.001 = conversion of milligrams to grams, and

15.43 = conversion of grams to grains.

6.1.3 Chloride Mass Emission Rate Calculations

Scrubber efficiency (SE), used to determine chloride species removal, will be calculated as follows:

$$SE = \frac{Cl_{in} - Cl_{out}}{Cl_{in}} \times 100\%$$

where: Cl_{in} = mass feed rate of chlorine entering the incinerator, and

Cl_{out} = mass emission rate of chlorine (as hydrogen chloride) in the scrubber exhaust gas prior to emission to the atmosphere.

6.1.4 Stack Gas Volumetric Flow Rate

The stack gas volumetric flow rate will be determined on several bases.

6.1.4.1 Stack Gas Velocity Calculation

The velocity of the stack gases based on EPA Method 2 will be calculated as:

$$V_s = 85.48\ C_p \quad \frac{(T_s)(\ \ P)}{(P_s)(M_w)}^{1/2}$$

where: pitot tube constant = $85.48 \frac{ft}{sec} \left[\frac{(lb/lb\text{-}mole)(in.\ Hg)}{(°R)(in.\ H_2O)}\right]^{1/2}$

V_s = velocity of the flue gas (ft/sec),

P = average differential pressure measured by S-type pitot (in. H_2O),

T_s = average gas temperature in duct (°R),

P_s = absolute duct pressure (in. Hg),

M_w = wet gas molecular weight (lb/lb-mole), and

C_p = S-type pitot correction factor (normally 0.84).

6.1.4.2 Stack Gas Volumetric Flow Rate Calculation - Actual Conditions

The volumetric flow rate of the stack gases based on EPA Method 2 will be calculated as:

$$Q_{ac} = 60\ (V_s)(A)$$

where: Q_{ac} = actual volumetric flow rate (acfm),
V_s = velocity of the flue gas (ft/sec),
A = cross-sectional area of the duct (ft_2), and
60 = conversion from seconds to minutes.

6.1.4.3 Stack Gas Volumetric Flow Rate Calculation - Dry Standard Conditions

The volumetric flow rate of the stack gases at dry standard conditions based on EPA Method 2 will be calculated as:

$$Q_{sd} = (1 - B_w)(Q_{ac})(528/T_s)(P_s/29.92)$$

where: Q_{sd} = dry volumetric flow rate at standard conditions (dscfm),

Q_{ac} = actual volumetric flow rate (acfm),

B_w = moisture fraction,

528 = standard temperature (°R),

T_s = average gas temperature in duct (°R),

29.92 = standard pressure (in. Hg), and

P_s = absolute duct pressure (in. Hg).

6.1.5 CO, CO_2, O_2, NO_x, and THC Concentration Calculations *

Response factors (RF) for the continuous monitors will be calculated from the single point RF check and the instrument zero value as follows:

$$RF = \frac{C_{std}}{[(\%\ FS)_{std} - (\%\ FS)_{zero}]}$$

Using this response factor, the sample concentration will be calculated using the following equation:

$$C_{smpl} = [(\%\ FS)_{smpl} - (\%\ FS)_{zero}] \times RF$$

where: RF = response factor or calibration factor for the parameter calibrated, CO, CO_2, O_2, NO_x, or THC. *

C_{std} = certified concentration of the parameter in the calibration gas,

$(\%\ FS)_{std}$ = calibration standard response expressed as percent of full-scale output (on strip chart recorder or instrument output voltage),

$(\%\ FS)_{std}$ = zero standard response expressed as percent of full-scale output, and

$(\%\ FS)_{smpl}$ = sample response expressed as percent of full-scale output.

6.1.6 Waste Feed Rate Calculations

The concentration of PCB, PCDD/PCDF, volatile and semi-volatile priority pollutants, and metals will be reported in units of micrograms per gram for the waste feed solids. These values will be reported for each composite sample for each run. The total mass rate of the individual compounds fed to the incinerator during each burn will be calculated from these concentrations and the process operation data for the amount of each feed material fed to the incinerator during each burn.

6.1.7 Solids/Liquids Analysis Calculations

The concentration of PCB, PCDD/PCDF, volatile and semi-volatile priority pollutants, and metals will be reported in units of microgram per liter for the liquid samples and in units of microgram per gram for the solid samples for each test.

6.1.8 Mass Balance

The concentration of chlorine and metals in the waste feed, liquids, solid samples and stack gas emissions will be determined. Mass balances for the compounds will be evaluated as follows:

$$W_{in} + S_{in} = SG_{out} + S_{out} + A_{out}$$

where: W_{in} = compound in waste feed in,

S_{in} = compound in liquid in,

SG_{out} = compound in stack gas emission,

S_{out} = compound in liquids out, and

A_{out} = compound in solid samples out.

6.2 Data Validation

All measurement data will be validated based upon representative process conditions during sampling or testing, acceptable sample collection and testing procedures, consistency with expected and/or other results and adherence to prescribed QC procedures. Any suspect data will be flagged and identified with respect to the nature of the problem with validity. Suspected outliers will be tested using the Dixon Criteria at the five percent significance level.

6.3 Reporting

Reporting responsibilities for this project are shown in Table 6-1.

Radian will evaluate the results of the demonstration test for completeness and representativeness and will perform the calculations for chlorine removal, particulate matter concentrations, emission rates, and other required data. A report of the results of the demonstration test will be submitted to Enviresponse within 60 days after completion of sampling. Data and results interpretation will be presented as necessary in the report. The report will also detail sampling and analytical procedures used during the demonstration test program.

TABLE 6-1. SUMMARY OF DATA REDUCTION, REVIEW, AND VALIDATION AND REPORTING RESPONSIBILITIES

Task	Personnel Responsibilities		
	Data Reduction	Data Review and Validation	Reporting
Quality Assurance Project Plan		D.L. Lewis	M.R. Fuchs
Site-Specific Data Summaries	Field Team Members	M.J. Krall	M.J. Krall
Final Report Outline		M.J. Krall	M.R. Fuchs
Draft Final Report		M.R. Fuchs	M.J. Krall
Final Report		M.R. Fuchs	M.J. Krall

7.0 INTERNAL QUALITY CONTROL CHECKS

Specific QC procedures will be followed to ensure the continuous production of useful and valid data throughout the course of the Haztech/Shiro incinerator demonstration test. The QC checks and procedures described in this section represent an integral part of the overall sampling and analytical scheme. Strict adherence to prescribed procedures is quite often the most applicable QC check. A discussion of both the sampling and analytical QC checks that will be utilized during this program is presented below.

7.1 Sampling Quality Control Checks

Prior to actual sampling on site, all of the applicable sampling equipment will be thoroughly checked to ensure that each component is clean and operable. Each of the equipment calibration data forms will be reviewed for completeness and adequacy to ensure the acceptability of the equipment. Each component of the various sampling systems will be carefully packaged for shipment. Upon arrival on site, the equipment will be unloaded, inspected for possible damage, and then assembled for use.

The following QC checks are applicable to each of the EPA Methods 2, 3, 4, and 5, Modified Method 5, SASS, VOST, metals, and HCl trains.

1. Each sampling train will be visually inspected for proper assembly before every use.
2. All sampling data will be recorded on standard data forms which will serve as pre-test checklist.
3. The oil manometer or Magnehelic® gauge to be used to indicate the differential pressure (ΔP) across the S-type pitot tube will be leveled and zeroed.
4. The number and location of the sampling traverse points will be checked before taking measurements.

5. The temperature measurement system will be visually checked for damage and operability by measuring the ambient temperature prior to each traverse.

6. Duplicate readings of temperature and differential pressure will be taken at each traverse point.

7. All sampling data and calculations will be recorded on preformatted data sheets.

In addition to the general QC procedures listed above, QC procedures specific to each sampling method will also be incorporated into the sampling scheme. These method specific procedures are discussed below.

7.1.1 Sampling Quality Control Procedures for SASS, Modified Method 5, Method 5 and VOST *

Samples for PCB, PCDD/PCDF, and semivolatile organics analyses will be collected according to the SASS protocol. Total particulate mass, metals, * and chloride species concentrations in the stack gas will be determined using EPA Method 5. Volatile organics will be determined using VOST. Soluble chrome will be determined using a version of the Modified Method 5 train. Quality control for sampling will focus on the following as appropriate for the individual sampling trains.

1. Prior to sampling, each SASS and M5 filter will be placed in a labeled, individual precleaned glass or plastic petri dish. *

2. For SASS and VOST sampling, all cleaned glassware, hardware, and prepared sorbent traps will be kept closed with ground glass caps or precleaned foil until assembly of the sample train in the field. The sorbent traps will be immediately recapped when the train is disassembled. *

3. Assembly and recovery of the sample trains will be performed in an environment free from uncontrolled dust.

4. For SASS and VOST sampling, sample train blanks will be collected. *

5. Prior to sampling, calculations will be made to determine the proper size nozzle required to attain isokinetic sampling.

6. The sampling nozzle will be visually inspected before and after each run for damage.

7. The S-type pitot tube will be visually inspected before and after each run for damage.

8. Each leg of the S-type pitot tube will be leak-checked before and after each run.

9. The oil manometer or Magnehelic® gauge to be used to indicate the differential pressure (ΔP) across the S-type pitot tube will be leveled and zeroed.

10. The number and location of the sampling points will be checked before taking measurements.

11. The temperature measurement system will be visually checked for damage and operability.

12. During sampling, the roll and pitch axis of the S-type pitot tube and the sampling nozzle will be properly maintained.

13. The entire sampling train will be leak-checked before and after each run. If the sampling train is moved from one sampling port to another during a run, the train will be leak-checked before and after the move.

14. Additional leak checks will be performed if the sampling time exceeded four hours.

15. The filter and sorbent trap will be maintained at the proper temperature throughout the test run.

16. Ice will be maintained in the ice bath throughout each run.

17. Dry gas meter readings, ΔP and ΔH readings, temperature readings, and pump vacuum readings will be properly made during sampling at each traverse point.

18. Isokinetic sampling will be maintained within $\pm10\%$.

19. In weighing the filters, both prior to and after sampling, repeat weighings will be performed $\geq$ six hours after the initial weighings. Repeat weighings must agree within ±0.2 mg to be considered acceptable.

20. For M5 sampling, blank determinations will be performed on each lot of acetone rinse solution. Blank residues must be ≤0.01 mg/g or 0.001% of the blank weight.

7.1.2 Quality Control Procedures for Velocity/Volumetric Flow Rate Determinations

Data required to determine the volumetric gas flow rate will be collected using the methodology specified in EPA Method 2. Quality control will focus on the following procedures.

1. The S-type pitot tube will be visually inspected before and after sampling.
2. Both the low-pressure and high-pressure legs of the S-type pitot tube will be leak-checked before and after sampling.
3. The oil manometer or Magnehelic® gauge to be used to indicate the differential pressure (ΔP) across the S-type pitot tube will be leveled and zeroed.
4. The number and location of the sampling traverse points will be checked before taking measurements.
5. The temperature measurement system will be visually checked for damage and operability by measuring the ambient temperature prior to each traverse.
6. All sampling data and calculations will be recorded on preformatted data sheets.

7.1.3 Sampling Quality Control Procedures for Moisture Determination

The moisture content of the gas streams will be determined using the technique specified in EPA Method 4. The following internal QC checks will be performed as part of the moisture determinations.

1. Each impinger will be weighed to the nearest 0.1 grams before and after sampling.
2. The sampling train, including impingers, will be leak-checked before and after each run.
3. Ice will be maintained in the ice bath throughout the run.
4. Any unusual conditions or occurrences will be noted during each run on the appropriate data form.

5. The field sampling team leader will review sampling data sheets daily during testing.

7.1.4 Quality Control Procedures for Molecular Weight Determinations

Samples to be used for determination of stack gas molecular weight will be collected using the grab sampling technique specified in EPA Method 3. Quality control for the Method 3 sampling will focus on the following.

1. The sampling probe will be stainless steel and equipped with a filter (glass wool plug) to remove particulate matter.
2. The sampling train will be purged prior to sample collection.
3. The sampling port will be properly sealed to prevent air in-leakage.

7.1.5 Quality Control Procedures for the HCl Trains

The sample to be used for determining HCl concentrations in the stack gas will be obtained using a modified sampling train. Quality control will focus on the following.

1. Prior to sampling, the impinger trains will be properly assembled for use. The first and second impingers will contain 0.1 N NaOH solution. The third impinger will be dry, while the last impinger will contain silica gel.
2. The entire sampling train will be leak-checked before and after each run.
3. The probe and sample line prior to the impinger train will be maintained above the dew point of the sample gas.
4. Ice will be maintained in the ice bath throughout each run.
5. Dry gas meter readings will be properly made at the start and end of sampling.
6. A constant (i.e., within 10%) sampling rate will be maintained.

7.2 Analytical Quality Control Procedures

All analyses for this program will be performed using accepted laboratory procedures in accordance with the specified analytical protocols. Gas standards used for quantitation will be certified (± 2% accuracy) standards or standards prepared according to EPA Traceability Protocol #1. Adherence to prescribed QC procedures will ensure data of consistent and measurable quality. Analytical quality control will focus upon the use of control standards to provide a measure of analytical precision. Also, specific acceptance criteria are defined for various analytical operations, including calibrations, control standard analyses, drift checks, blanks, etc. The following general QC procedures will be incorporated into the analytical effort.

1. The on-site testing team leaders will review all analytical data and QC data on a daily basis for completeness and acceptability.
2. A master logbook will be maintained.
3. Analytical QC data will be tabulated using the appropriate charts and forms on a daily basis.
4. Copies of the QC data tabulation will be submitted to the QA Coordinator following each test, with all originals kept on file.
5. All hard copy raw data (i.e., chromatograms, computer printouts, etc.) will be maintained in organized files.

Specific analytical QC procedures for each of the instrumental analyses are discussed below.

7.2.1 CEMS Quality Control Procedures

During the testing program, CEMS operation will include the following general QC procedures.

1. CEMS data will be collected using a central computerized data acquisition system.
2. All calibration standards will be certified standards (± 2% analytical accuracy).
3. All CEMS calibration data, QC data, and maintenance operations will be recorded in bound laboratory notebooks or on preformatted data sheets.

In addition to these general QC considerations, CEMS drift checks for CO, CO_2, O_2, NO_x, and THC will be performed routinely to ensure that the * monitoring data remain within precision and accuracy limits specified in the performance specifications. Each day, a low-level and high-level gas will be introduced to each monitor. Drift will be defined as the difference between the monitor value and the actual concentration of the standard, expressed as a percentage of the span value. Drift checks will be performed prior to any calibration or zero adjustment. For the O_2 and CO_2 monitors, the acceptance limit is 0.5% O_2 or CO_2 (absolute). The acceptance limit for the CO, NO_x, and * THC monitors is 5% drift.

7.2.2 Quality Control Procedures for GC/MS Analysis

Internal quality control checks on the GC/MS analysis will consist of daily tuning of the mass spectrometer, analysis of GC column performance standards, calibration checks, and analysis of surrogate spikes for extraction efficiency. A multipoint calibration curve and response factor for the compounds of interest will be developed.

The mass spectrometer will be tuned on a lock-mass basis to a 4-bromofluorobenzene (BFB) standard for liquid and solid sample analysis for V-PP+10 and a decafluorotriphenylphosphine (DFTPP) standard for analysis for SV-PP+10. A GC column performance standard will be analyzed with a 10% valley resolution criteria. Prior to extraction, each sample will be spiked with isotope-labeled surrogate compounds as a check on extraction efficiency. A mid-range native calibration standard will be analyzed at the end of the day to assess instrument drift.

For the measurement of the organic constituents collected by the SASS train and VOST, at least one method blank and one field blank will be analyzed with each set of field samples. *

7.2.3 Quality Control Procedrues for Chloride Analyses

Following Method 27 from the "FGD Chemistry and Analytical Methods Handbook", Radian Corporation, Volume 2, July 1984, a Dionex Ion Chromatograph will be used to determine chloride concentrations in the impinger catch from the HCl train. This analysis method involves the generation of a standard calibration curve. This curve is a linear plot of analyte concentration versus instrument response (conductivity or absorbance). The calibration curve is generated using response data from analysis of the blanks and calibration standards. This data is plotted mathematically using linear regression to get the slope, y- intercept, and correlation coefficient of the calibration curve. The validity of the resulting curve may be assessed by examining these three items. The slope of the curve is related to response sensitivity. Any marked deviation from the average slope for the method and/or parameter of interest indicates that a change in sensitivity has occurred. The acceptance criterion for slope will be agreement with running mean slope for six most recent determinations within 10%. The y-intercept of the curve should ideally be equal to zero, i.e., instrument response to a blank should be zero and the calibration curve should pass through the origin. In practice, the curve rarely passes exactly through the origin.

The correlation coefficient is indicative of the linearity of the curve. According to Beer's law, the response should be directly proportional to concentration. Perfect correlation of the x and y data points is indicated by a correlation coefficient of 1.0. An acceptable calibration curve will have a correlation coefficient $\geq$0.9950.

7.2.4 Quality Control for Fixed Gas Analysis

Fixed gas analysis for molecular weight determination will be based on EPA Method 3. Quality control procedures will include two or more single point calibrations prior to the field test activities. The acceptance criteria for the single point calibrations will be duplicate analysis within ≤5% (CV). A control standard will also be analyzed prior to the test to provide an estimate of accuracy. The acceptance criteria for the control standard will be agreement within 10% of the theoretical value.

8.0 PERFORMANCE AND SYSTEM AUDITS

No performance or systems audits are planned for this project.

9.0 DATA QUALITY INDICATORS

The QC analyses conducted during the testing program are designed to provide a quantitative assessment of the measurement system data. The two aspects of data quality which are of primary concern are precision and accuracy. Accuracy reflects the degree to which the measured value represents the actual or "true" value for a given parameter and includes elements of both bias and precision. Precision is a measure of the variability associated with the measurement system. The completeness of the data will be evaluated based upon the valid data percentage of the total tests conducted.

9.1 Precision

Precision by the definition presented in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems. Volume I: Principles (EPA-600/976-005) is "a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions." Different measures of precision exist, depending upon these "prescribed similar conditions."

Quality control procedures, such as control sample analyses and replicate analyses, represent the primary mechanism for evaluating measurement data variability or precision. Replicate analyses will be used to define analytical replicability, while results for replicate samples may be used to define the total variability (replicability) of the sampling/analytical system as a whole.

Precision of the measurement data for this program will be based upon replicate analyses (replicability) and control sample analyses (repeatability). Variability will be expressed in terms of the coefficient of variation (CV) for the replicate and repeat analyses where;

$$\% \text{ CV} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100\%$$

This term is independent of the error (accuracy) of the analyses and reflects only the degree to which the measurements agree with one another, not the degree to which they agree with the "true" value for the parameter measured.

Relative percent difference (RPD), given by

$$\%\ \text{RPD} = \frac{\text{Maximum Value} - \text{Minimum Value}}{[\ (\text{Maximum Value} + \text{Minimum Value})/2]} \times 100,$$

is commonly used to express variability between duplicate measurements because it is easily calculated and measurement distribution is always normal for duplicate results. For duplicate (n = 2) measurements, relative percent difference is related to the sample (n - 1) coefficient of variation by:

$$\%\ \text{RPD} = \sqrt{2} \times (\%\ \text{CV})$$

For consistency in comparing variability estimates for duplicate and larger replicate sets, and so that pooled % CVs may be calculated to estimate overall measurement distribution, variability estimates will be reported in terms of % CV.

9.2 Accuracy

Accuracy is the agreement between a measurement value and a theoretical value. Accuracy will be expressed as the relative error (% RE) where:

$$\%\ \text{RE} = \frac{\text{Measured Value} - \text{Theoretical Value}}{\text{Theoretical Value}} \times 100,$$

This accuracy estimate includes error due to both imprecision and bias.

The accuracy objectives in Table 3-1 represent error for analysis of target analytes spiked in the actual sample matrix, except for continuous flue gas measurements. Accuracy estimates for CEMs will be based on analysis of audit gases.

The analytical systems will also be checked routinely for system
accuracy in the absence of matrix effects. The following equation will be *
used to calculate matrix spike recovery: *

$$\% \text{ Recovery (spike)} = \frac{C_{ss} - C_{us}}{C_{sa}} \times 100$$ *

where:

C_{ss} = Analyte concentration in spiked sample; *
C_{us} = Analyte concentration in unspiked sample; and *
C_{sa} = Analyte concentration added to the sample. *

If matrix spike error exceeds the specified acceptance criteria, a QC check sample (analyte spiked in DI water) will be analyzed to determine whether the error was due to matrix interferences or to an assignable cause of error in the analytical system itself. Data which are not within the acceptance criteria for matrix spikes will be flagged.

Daily control sample analyses represent one mechanism for controlling measurement system error. Typically, repeated measurements are made of the parameter of interest for the same control sample or for additional samples at different levels, and the average error is calculated. This error value represents an estimate of measurement bias or systematic error, although it is often simply referred to as "accuracy." The significance of the bias estimate may be evaluated using confidence intervals. An approximate 95% confidence interval for the mean error (bias) can be calculated using:

$$\text{Mean (X)} \pm t_{.025,\ (n-1)} \frac{\text{Standard Deviation}}{\sqrt{n}}$$

where n is the number of measurements used to compute the average and standard deviation and t is a table statistical value (0.025 confidence level, n - 1 degrees of freedom; when n is greater than 10, t approaches 2.0).

As an example, for a particular set of nine measurements, assume an overall mean of 20 ppm is reported, and the standard deviation of these data is 10 ppm. Also, assume that the true concentration is 30 ppm. For these measurements, the 95% confidence interval is:

$$20 \pm 2.3 \frac{10}{\sqrt{9}} \qquad \text{or} \qquad 20 \pm 7.7$$

which is the interval (12,28). Since this interval does not include the true value, 30 ppm, a conclusion of bias is justified. The magnitude of this bias is between 2 and 18 ppm. The uncertainty in the estimate is due to variability arising from random error.

Daily control samples analyses will be used to assess measurement bias. The average degree of agreement between measured values and actual values for control samples provides a long-term, or average estimate of measurement bias, as well as precision (repeatability).

9.3 Completeness

Measurement data completeness is a measure of the extent to which the data base resulting from a measurement effort fulfills objectives for the amount of data required. For this program, completeness will be defined as the valid data percentage of the total tests planned. As previously shown in Table 3-1, this valid data percentage will be 90% for all tests.

10.0 CORRECTIVE ACTION

During the course of the Haztech/Shirco incinerator testing program, it will be the responsibility of the field task leader and the sampling team members to see that all measurement procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. In the event a problem arises, it is imperative that prompt action be taken to correct the problem(s). The field team leaders will initiate corrective action in the event of QC results which exceed acceptability limits. Corrective action may also be initiated by the team leaders upon identification of some other problem or potential problem. Corrective action may be initiated by the QA Coordinator based upon QC data or audit results. The corrective action scheme is shown in the form of a flow chart in Figure 10-1.

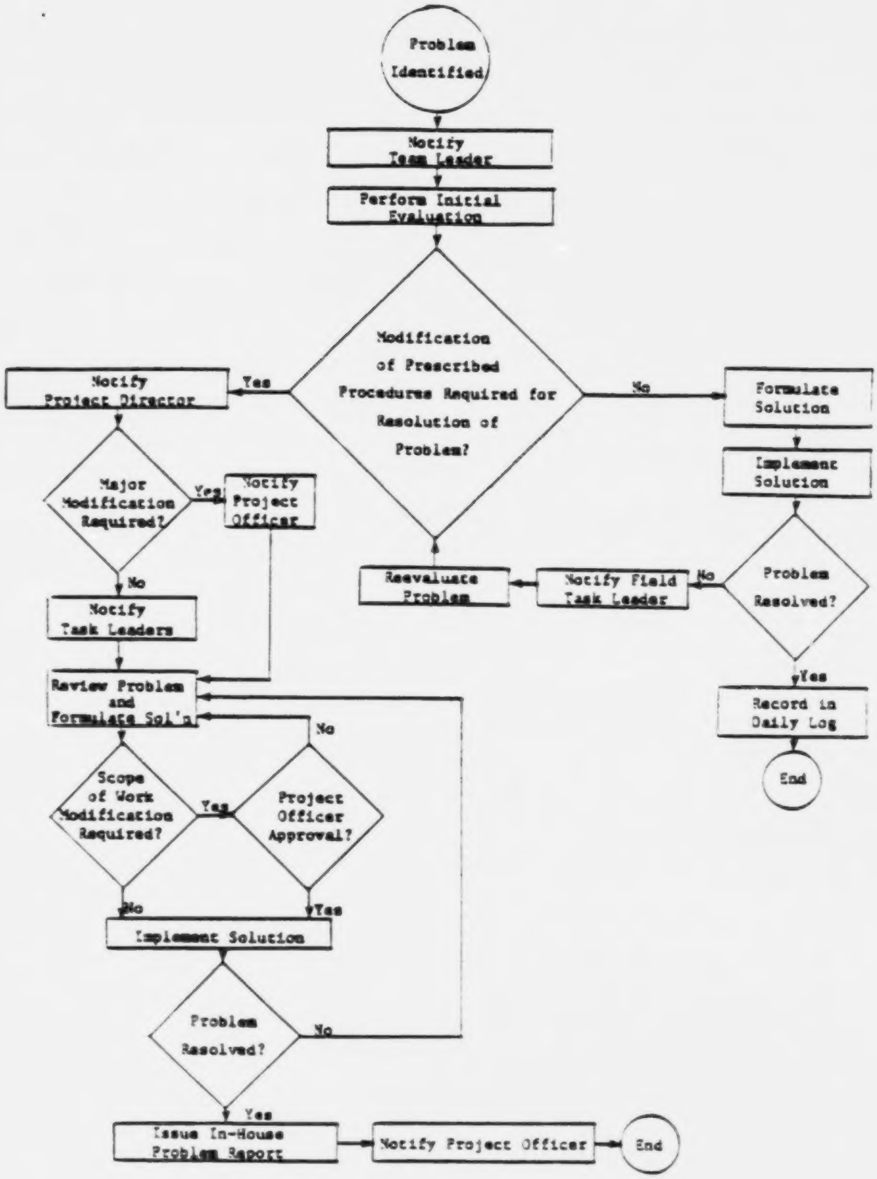

Problem Identified
Notify Team Leader
Perform Initial Evaluation
Modification of Prescribed Procedures Required for Resolution of Problem?
Yes
No
Notify Project Director
Formulate Solution
Implement Solution
Major Modification Required?
Yes
Notify Project Officer
No
Notify Task Leaders
Problem Resolved?
No
Notify Field Task Leader
Reevaluate Problem
Yes
Record in Daily Log
End
Review Problem and Formulate Sol'n
No
Scope of Work Modification Required?
Yes
Project Officer Approval?
No
Yes
Implement Solution
Problem Resolved?
No
Yes
Issue In-House Problem Report
Notify Project Officer
End

Figure 10-1. Corrective Action Flow Scheme

11.0 QUALITY ASSURANCE REPORTING

Effective management of a field sampling and analytical effort requires timely assessment and review of field activities. This will require effective interaction and feedback between the field team leader, the Project Director, and the QA Coordinator.

During the Haztech/Shirco incinerator test, the field team leader will submit a verbal QC report to the Radian QC Coordinator. This report will address the following:

- summary of activities and general program status;
- summary of corrective action activities;
- assessment and summary of data completeness; and
- summary of any significant QA/QC problems and recommended and/or implemented solutions not included above.

The project final report will include a separate QA/QC section which addresses QA/QC aspects of the project.

Problems requiring swift resolution will be brought to the immediate attention of the Project Director via the corrective action scheme discussed in Section 10.

12.0 PROJECT SAFETY

A primary objective of the testing activity is that it be performed in a safe and prudent manner. The site is a controlled, limited-access facility that presently meets or exceeds applicable safety standards. Radian will comply strictly with the facility's safety program. However, in order to minimize any risks, the Radian team will be equipped and prepared for emergency situations likely to occur.

The following discussion contains information regarding general safety procedures and site-specific safety considerations.

12.1 General Safety Procedures

The safety procedures and protective equipment required on site will vary according to the type of activity in progress and one's proximity to the sampling area. The field task leader will serve as safety coordinator and will decide the types of protective equipment to be used and the delineation of safety zones on the job site.

12.1.1 Safety Zones

Safety zones will be established according to the exposure levels encountered. It is anticipated that only Level-One and Level-Two zones will be required at this work site. The following three-level exposure system will be used:

- Level One--The exposure level is very low hazard associated with site activities. Low hazard area requires little or no safety equipment.

- Level Two--An exposure level exists which requires intermediate precautions. Hazard potential is defined and safety equipment is required.

- Level Three--An extreme exposure level exists and strict safety precautions are required. This exposure level is considered life-threatening.

No Level Three exposure is considered likely to occur. The safety coordinator will inform workers as to what safety zone they will be in and what safety equipment will be required prior to field testing.

12.2 Safety Equipment

Equipment will be available to protect each worker from Level Two exposure. In addition, the following equipment will be available on site:

- Ear protection;
- Emergency eye washes; and
- First aid supplies.

12.3 Safety Training

Prior to the initiation of on-site work, the field task leader will conduct a safety meeting. The meeting will inform the project personnel of the potential and real hazards present, instill in them the necessity for safety precautions, and develop their understanding of proper safety measures. Instructions as to the use of various safety equipment and procedures will be given if necessary. Also, a contingency plan for emergency situations will be discussed.

12.4 Site-Specific Safety Procedures

Radian personnel will comply strictly with all the safety requirements of the facility, particularly with respect to hard hats, steel-toed boots, eye protection, and long-sleeved shirts.

Chemical exposure may be minimized by the use of protective clothing, respirators equipped with acid/organic canisters, disposable gloves, and Tyvek© suits when working in the immediate vicinity of the high level sources. The necessity of these measures will be decided by the project safety officer. Gloves will be worn when handling sludge and liquid samples and filling sampling containers.

27. Analysis of Anions (Fluoride, Chloride, Sulfite, Sulfate, and Phosphate) in Scrubber Liquors and Solids by Ion Chromatography with Modified Anion Eluent

1.0 DESCRIPTION OF METHOD

This procedure uses ion chromatography to analyze fluoride, chloride, sulfate, sulfite, and phosphate in scrubber liquors and total sulfur as sulfate in scrubber solids. The ions are separated on anion exchange resins and detected conductimetrically. The five anions of interest are separated with a Dionex fast-run AS3 separator. An AG3 guard column precedes the separator column. A packed-bed suppressor column is between the separator and the conductivity detector. The standard anion eluent is modified in this procedure to improve peak resolution. Formaldehyde is used as a sample preservative to inhibit sulfite oxidation and to allow direct sulfite and sulfate analysis in the same sample.

Eluent and injected solution first enter the guard column where most particulates and organic contaminants are trapped before they can reach and possibly damage the separator. Separation occurs according to anion size and resin affinity in the next column, the anion separator. Eluent and separated anionic species then enter the suppressor column where response to the background eluent ions is eliminated. The conductivity cell detects the separated anions and produces an electronic response that is recorded with a strip chart recorder as a function of time. For a given set of conditions, the elution time is characteristic of the species measured. Peak heights are proportional to species concentrations. The peak heights recorded for sample injections are compared with calibration curves for each anion to determine concentration in the sample.

2.0 SIGNIFICANCE AND USE

This procedure can be used to analyze a number of different anions in both liquid and solid samples from FGD systems provided high molar ratios of species do not prevent resolution of the peaks of interest. This method has two significant advantages over other methods for the anions of interest. First, it is faster than analyzing the anions separately using a different method for each anion. Second, it allows the direct determination of sulfite and sulfate in one sample. The other alternatives for sulfite and sulfate analysis require immediate determination of sulfite on one sample of a material at the time of sampling, oxidation of sulfite to sulfate in another sample, determination of total sulfate on the oxidized sample, and calculation of sulfate by difference.

This method can be used to determine chloride and sulfate in samples from lime, limestone, dual alkali and magnesia FGD systems. It can be used for chloride, sulfite, and sulfate in all but high TDS systems in which sulfite concentration is very low (8-10 mg/L). Its application for fluoride and phosphate analysis is probably limited to low TDS lime or limestone systems in which chloride and sulfate concentrations are low enough to allow peak resolution. There are little or no reliable data to indicate typical levels of fluoride and phosphate in scrubber liquors, so it is possible that the actual concentrations of these anions are too low to be measured by this method.

3.0 DETECTION LIMIT AND RANGE OF METHOD

Maximization of instrument sensitivity was not an objective in developing this procedure. The detection limit and range for the operating conditions used in this procedure (30 µmhos/cm, 50% modified eluent, and 33% flow) are shown in Table 1.

Calibration lines based on peak heights (method recommended rather than peak area by the instrument manufacturer) are nonlinear for peak heights less than about 10 percent of full scale. The lowest standard should have a concentration so that the peak height is about 20 percent of full scale. The detection limits listed in Table 1 have been defined as one-half the concentration of the lowest standard, and the preferred range for measurement as the range from the concentration of the lowest standard to the concentration of the highest standard. Concentrations above the upper limit can be brought into the preferred range by dilution.

Table 1

ANION DETECTION LIMITS AND MEASUREMENT RANGES

Anion	Detection Limit (mg/L)	Range (mg/L) Low	Range (mg/L) High
F^-	0.247	0.494	3.95
Cl^-	0.709	1.42	8.51
SO_3^{-2}	2.40	3.20	22.4
SO_4^{-2}	1.92	3.84	26.9
PO_4^{-3}	3.80	7.60	22.8

4.0 ELAPSED TIME AND LABOR HOURS REQUIRED

Reagent preparation requires between 90 and 120 minutes before initial instrument operation. Other daily preparations average between 15 and 30 minutes.

Assuming that a stable baseline has been established and that all standard solutions have been prepared, analysis of the first sample within the concentration range of the standards takes approximately 78 minutes, 35 of which involve operator time. This allows time for injection of a blank, four standards for a calibration curve, and a sample. Each additional sample will take 13 minutes to analyze. Instrument start-up and baseline stabilization will add 40 minutes to the time required from receipt of sample to final answer. Since calibration should be repeated within 4 hours of start-up, a total of 10 to 13 samples may be analyzed per calibration. The actual number of samples analyzed depends on anion concentrations in the samples, which affect elution time and suppressor column capacity. If sample concentrations in original dilutions are not in the preferred range, additional dilutions and injections must be made. This reduces the number of samples that can be analyzed per calibration. An ASC-2 packed-bed suppressor column can normally be operated 6 to 8 hours before regeneration is necessary. A steady upward drift of the baseline indicates the need for regeneration.

5.0 DEFINITIONS

anion exchange resin - a synthetic organic exchange material capable of the reversible exchange of negatively charged ions

regeneration - the part of the operating cycle of an ion-exchange process in which a chemical solution is passed through the ion-exchange bed to prepare it for service runs

retention time - the time that elapses from the introduction of the sample until the component peak maximum is reached

eluent - liquid medium that carries injected samples/solutions through the ion separator column

conductivity cell - an analytical detector that measures electrical conductivity

6.0 INTERFERENCES/SOURCES OF ERROR

The main source of interference in ion chromatography is overlapping or unresolved peaks. To help reduce peak overlap and to keep analysis time as short as possible, a 50% strength modified anion eluent (0.0013 M NaOH and 0.00175 M Na_2CO_3) at a flow rate of 33% is used. Retention times at these conditions are given in Table 2. Interference considerations are noted below.

Table 2

AVERAGE RETENTION TIMES USING 50 PERCENT MODIFIED ELUENT AT A FLOW RATE OF 33 PERCENT

Species	Retention Time (minutes)
Fluoride	2.2
Chloride	2.9
Sulfite	5.9
Sulfate	7.8
Phosphate	11.2

Phosphate peak resolution is not achievable at these conditions in solutions containing high sulfate-to-phosphate molar ratios. Peak resolution might be achieved at other conditions, but the analysis time per sample might be unacceptably long.

Sulfate-to-sulfite molar ratios of 75:1 or greater prevent adequate separation of the sulfite peak in solutions with low sulfite concentration.

Fluoride peak resolution is affected by chloride present in molar concentrations greater than sixty times the fluoride concentration and sulfate present in molar concentrations greater than 200 times the fluoride concentration.

This procedure calls for addition of formaldehyde as a sample preservative at the time of sample collection. Formaldehyde is added at 5 times the sulfite concentration to retard or inhibit sulfite oxidation. Addition of formaldehyde at 5 times the sulfite concentration to sulfite, sulfate, chloride, fluoride, and phosphate standards showed that formaldehyde had no effect on analysis of standards and no formaldehyde interference is expected in analysis of any of the anions in scrubber liquors.

7.0 ALTERNATE METHODS

Ion chromatography provides rapid analyses of anions in scrubber samples. The cost of purchasing the instrument and training operators often must be justified by the number of samples to be analyzed. Several methods for analyzing each of the anions covered in this procedure are provided in this handbook. The choice of method will depend on the concentration range of the anion in the sample, the time required to perform the procedure, interferences, the degree of accuracy required, and the number of samples to be analyzed. These elements are summarized in Tables 3 through 7 for the chloride, fluoride, sulfate, sulfite and phosphate methods included in this handbook.

8.0 PRECAUTIONS/CRITICAL STEPS

- Columns may be damaged if not thoroughly rinsed with deionized water between eluent and regenerant cycles.
- Greater resolution between peaks may be achieved by:
  - Use of a weaker eluent,
  - Addition of separator columns (the greater the number of active separator sites, the greater the possible resolution),
  - Decrease in flow rate.
- Never increase flow rate when columns are in line, or when pump is not operating. Doing so may result in liquid leaks at column fittings or damage to the pump's internal flow control mechanism.
- For instrument problems consult the ion chromatograph operators' manual.
- Different dilutions (and therefore separate injections) may be required for determination of species present in high and low concentrations. The conditions specified in this procedure will not yield adequate resolution of peaks if the molar ratio of two species with similar retention times is very large. Section 6 specifies the molar ratios of concern for this procedure.

Table 3

CHLORIDE METHODS COMPARISON

Method	Range	Interferences/ Sources of Bias	Applications	Preparation Time[a] (hr)	Sample Analysis Time[b] (hr/single sample)	Single Operator Coefficient of Variation[c] (%)	Special Equipment Requirements
Ion Chromatography—50% Modified Anion Eluent	1.4 to 8.5 mg/L in the aliquot injected	Overlapping peaks, which may be resolved by changing eluent strength or flow rate	Liquors from lime, limestone, dual alkali, and magnesia processes	3.25	0.25	12.3	Ion chromatograph with anion separator and suppressor columns Strip chart recorder
Ion Chromatography—Standard Anion Eluent	1.4 to 8.5 mg/L in the aliquot injected	None	Liquors from lime, limestone, dual alkali and magnesia processes	2.75	0.15	1.7	Ion chromatograph with anion separator and suppressor columns Strip chart recorder
Mercuric Nitrate Titration	0.5 to 250 mg/L	Sulfite >10 mg/L (oxidize with peroxide) Iron III >10 mg/L (reduce with hydroquinone) Chromate >100 mg/L (reduce, use modified indicator)	Liquors from lime, limestone, dual alkali and magnesia processes. Applicability depends on presence of interfering ions.	2.5	0.35	3.0	Microburet
Silver Nitrate Titration with Chromate Indicator	2.5 to 100 mg/L	Iron II >10 mg/L Orthophosphate at 25-250 mg/L (uncommon except when cooling water blowdown is used for make-up water) pH (adjust to neutral or slightly alkaline) Turbidity (add $Al(OH)_3$ and filter) Sulfite and thiosulfate (oxidize with peroxide) Bromide, iodide, cyanide and sulfide (uncommon in scrubber liquors) Magnesium and sulfate at 200 times the chloride molar concentration	Liquors from lime, limestone, dual alkali and magnesia processes. Applicability depends on presence of interfering ions.	2.5	0.35	2.3	Microburet

Table 3 (continued)

CHLORIDE METHODS COMPARISON

Method	Range	Interferences/ Sources of Bias	Applications	Preparation Time[a] (hr)	Sample Analysis Time[b] (hr/single sample)	Single Operator Coefficient of Variation[c] (%)	Special Equipment Requirements
Potentiometric Titration with Silver Nitrate	5.0 to 100 mg/L	Chromate and dichromate (reduce to chromic ion) Ferric iron at concentrations substantially higher than chloride concentration Bromide, iodide, ferricyanide (uncommon in scrubber solutions) Sulfite and thiosulfate (oxidize with peroxide)	Liquors from lime, limestone, magnesia, and dual alkali systems	2.0	0.20	Pure liquors 2.5 Liquors containing interferences 5.0	pH meter with millivolt scale, electrodes, microburet

---

[a] Includes labor hours for equipment set up, instrument calibration, reagent preparation and standardization

[b] Elapsed time from receipt of one sample to calculated final result including sample preparation, analysis, and calculations. Clean-up time is not included. Actual labor hours are less than elapsed time in some cases. Labor hours per sample will be reduced if more than one sample is analyzed.

[c] Coefficient of Variation (CV) = (standard deviation/mean) x 100

$$CV = \frac{[\Sigma(X_i - \bar{X})^2/n - 1]^{1/2}}{\bar{X}} \times 100$$

where: X_i = individual measurement

n = number of replicates

$\bar{X}$ = mean of measurements

Table 4

FLUORIDE METHODS COMPARISON

Method	Range	Interferences/ Sources of Bias	Applications	Preparation Time[a] (hr)	Sample Analysis Time[b] (hr/ single sample)	Single Operator Coefficient of Variation[c] (%)	Special Equipment Requirements
Ion Chromatography with Modified Eluent	0.5 to 4 mg/L in aliquot injected	Chloride >60 times fluoride concentration interferes. Sulfate >200 times fluoride concentration interferes.	Liquors from low TDS lime or limestone FGD systems	Reagent and instrument prep-2.2 Calibration-1.0	0.25	14.9 (est.)	Ion chromatograph with anion separator and suppressor columns Strip chart recorder
SPADNS Colorimetric	0.10 to 2.5 mg/L	Chloride (add Ag_2SO_4 to distillation flask.) Sulfate, chloride, iron, aluminum, alkalinity, phosphate (acidify sample and distill.)	Unverified	3.5	Liquid 0.40 Solid 1.15 Add 1 hr for sample distillation.	Single operator 27 (est.) Multilab 16	Distillation glassware Spectrophotometer with cuvettes
Ion Selective Electrode	0.20 to 1000 mg/L	Polyvalent cations Al (III), Fe (III), Si (IV), (add pH 5 buffer containing chelating agent.) Fluoroborates (Distill the sample.)	Unverified	3.5	Liquid 0.40 Solid 1.15 Add 1 hr for sample distillation.	Single operator 2.4 (est.) Multilab 4.8	pH/millivolt meter Fluoride and reference electrodes

---

[a] Includes labor hours for equipment set up, instrument calibration, reagent preparation and standardization

[b] Elapsed time from receipt of one sample to calculated final result including sample preparation, analysis, and calculations. Clean-up time is not included. Actual labor hours are less than elapsed time in some cases. Labor hours per sample will be reduced if more than one sample is analyzed.

[c] Coefficient of variation (CV) = (standard deviation/mean) x 100

$$CV = \frac{\left[\sum (X_i - \bar{X})^2/n-1\right]^{1/2}}{\bar{X}} \times 100$$

where: X_i = individual measurement

n = number of replicates

$\bar{X}$ = mean of measurements

Table 5

SULFATE/TOTAL SULFUR METHODS COMPARISON

Method	Range	Interferences/ Sources of Bias	Applications	Preparation Time[a] (hr)	Sample Analysis Time[b] (hr/single sample)	Single Operator Coefficient of Variation[c] (%)	Special Equipment Requirements
Gravimetric	50 to 250 mg/L	Sulfite (oxidize with peroxide) Silica (uncommon at interfering levels) Suspended matter (remove by filtration)	Liquors and solids from all FGD systems	3.0	2.6 to 21 hrs, depending on length of digestion	Liquors 4.3 Solids 8.3	
Turbidimetric	5 to 40 mg/L	Sulfite (oxidize with peroxide) Silica (uncommon in FGD systems at interfering levels) Suspended matter (remove by filtration) Highly colored liquors (analyze samples without $BaCl_2$ addition)	Liquors and solids from all FGD systems	4.5	Liquid 0.40 Solid 0.50	Liquors 5.7 Solids 6.6	Spectrophotometer or nephelometer, cuvettes
Barium Chloride/ Thorin Titration	5 to 1000 mg/L	Potassium, iron, chromium, aluminum (pass sample through cation exchange column) Sulfite (oxidize with peroxide) Sulfide (uncommon in scrubber systems) Nitrate, phosphate, and fluoride (uncommon at levels high enough to interfere) Chloride concentrations greater than sulfate concentration obscure titration end point	Most FGD systems (not applicable to solutions with chloride concentrations much greater than sulfate concentration)	3.0	Liquid 0.50 Solid 0.60	Liquors 1.23 Solids 3.5	Burets Ion exchange column
Acid-Base Titration	96 to 2880 mg/L	Phosphate is also determined by this method, but is not usually present in significant amounts Carbonate/carbon dioxide (stop titration at pH 4.6) Sulfite (oxidize with peroxide) Resin particles in effluent (filter)	Liquors from lime/ limestone, magnesia, and dual alkali processes	3.0	3.0 to 7.0	1 (est.)	Microburets Ion exchange columns

Table 5 (continued)

SULFATE/TOTAL SULFUR METHODS COMPARISON

Method	Range	Interferences/ Sources of Bias	Applications	Preparation Time[a] (hr)	Sample Analysis Time[b] (hr/single sample)	Single Operator Coefficient of Variation[c] (%)	Special Equipment Requirements
Ion Chromatography--50% Modified Anion Eluent	3.8 to 27 mg/L in the aliquot injected	None	Liquors and solids from lime, limestone, dual alkali, and magnesia FGD processes	3.25	0.25	Liquors 3.7 Solids 4.1	Ion chromatograph with anion separator and suppressor columns Strip chart recorder
Ion Chromatography--Standard Anion Eluent	3.8 to 15 mg/L in the aliquot injected	None	Liquors and solids from lime, limestone, dual alkali, and magnesia FGD processes	2.75	0.15	0.75	Ion chromatograph with anion separator and suppressor columns Strip chart recorder

---

[a] Includes labor hours for equipment set up, instrument calibration, reagent preparation and standardization

[b] Elapsed time from receipt of one sample to calculated final result including sample preparation, analysis, and calculations. Clean-up time is not included. Actual labor hours are less than elapsed time in some cases. Labor hours per sample will be reduced if more than one sample is analyzed.

[c] Coefficient of variation (CV) = (standard deviation/mean) x 100

$$CV = \frac{[\Sigma(X_i - \bar{X})^2/n - 1]^{1/2}}{\bar{X}} \times 100$$

where: X_i = individual measurement
n = number of replicates
$\bar{X}$ = mean of measurements

Table 6

SULFITE METHODS COMPARISON

Method	Range	Interferences/ Sources of Bias	Applications	Preparation Time^a (hr)	Sample Analysis Time^b (hr/single sample)	Single Operator Coefficient of Variation^c (%)	Special Equipment Requirements
Ion Chromatography—50% Modified Anion Eluent	3.2 to 22.4 mg/L in aliquot injected	Overlapping or unresolved peaks (change eluent strength or flow rate) Sulfate to sulfite molar ratios $\geq$ 75 to 1	Liquors from all but high TDS systems in which sulfite concentration is very low (8-10 mg/L)	3.25	0.25	Liquids 80-40,000 mg/L 2.5	Ion chromatograph with anion separator and suppressor columns, strip chart recorder
Direct Iodine Titration	0.8 to 248 mg/L	Copper II and ferrous iron (complex with EDTA) Nitrite (destroy by sulfonic acid addition) Sulfide, thiosulfate, organic matter	Liquors from lime, limestone, magnesia, and dual alkali systems Not applicable to solids-cloudy solution masks starch end point	2.5	0.20	6.4	Buret
Iodine-Thiosulfate Titration	8.0 to 800 mg/L	Air oxidation of iodine (follow storage precautions) Extremes of pH (buffer samples to pH 6) Sulfide, thiosulfate, tin, iron, lead (not typically found in scrubber systems)	Liquors and solids from lime, limestone, dual alkali, magnesia systems	2.6	Liquids 0.25 Solids 0.50	Liquids 88-151 mg/L 4.6 2300-39000 mg/L 1.2 Solids Lime scrubber 0.9 Lime spray dryer 6.6	Buret

Table 6 (Continued)

SULFITE METHODS COMPARISON

Method	Range	Interferences/ Sources of Bias	Applications	Preparation Time[a] (hr)	Sample Analysis Time[b] (hr/single sample)	Single Operator Coefficient of Variation[c] (%)	Special Equipment Requirements
Iodine-Phenylarsine Oxide Titration	8.0 to 800 mg/L	Air oxidation of iodine (follow storage precautions) Extremes of pH (buffer samples to pH 6) Sulfide, thiosulfate, tin, iron, lead (not typically found in scrubber systems)	Liquors and solids from lime, limestone, dual alkali, magnesia systems	2.6	Liquids 0.25 Solids 0.50	Liquids 88-151 mg/L 3.5 2300-39000 mg/L 0.92 Solids 1.4	Buret
Iodine-Arsenite Titration	8.0 to 800 mg/L	Air oxidation of iodine (follow storage precautions) Extremes of pH (buffer samples to pH 6) Sulfide, thiosulfate, tin, iron, lead (not typically found in scrubber systems)	Liquors and solids from lime, limestone, dual alkali, magnesia systems	2.6	Liquids 0.25 Solids 0.50	Liquids 88-151 mg/L 5.6 2300-39000 mg/L 1.5 Solids 1.1	Buret

---

[a] Includes labor hours for equipment set up, instrument calibration, reagent preparation and standardization

[b] Elapsed time from receipt of one sample to calculated final result including sample preparation, analysis, and calculations. Clean-up time is not included. Actual labor hours are less than elapsed time in some cases. Labor hours per sample will be reduced if more than one sample is analyzed.

[c] Coefficient of variation (CV) = (standard deviation/mean) x 100

$$CV = \frac{[\Sigma(X_i - \bar{X})^2/n - 1]^{1/2}}{\bar{X}} \times 100$$

where: X_i = individual measurement

n = number of replicates

$\bar{X}$ = mean of measurements

Table 7

PHOSPHATE METHODS COMPARISON

Method	Range	Interferences/ Sources of Bias	Applications	Preparation Time[a] (hr)	Sample Analysis Time[b] (hr/single sample)	Single Operator Coefficient of Variation[c] (%)	Special Equipment Requirements
Ion Chromatography 50% Modified Anion Eluent	8 to 23 mg/L in the aliquot injected	High sulfate-to-phosphate molar ratios inhibit phosphate peak resolution.	Liquors from low TDS lime or limestone systems where chloride and sulfate concentrations are low enough to allow peak resolution	3.25	0.25	20	Ion chromatograph with anion separator and suppressor columns Strip chart recorder
Vanadomolybdate Spectrophotometric	1.0 to 18 mg/L (Refer to Method 53.)	Arsenic and silica at 133 mg/L may cause positive interference. Ferrous iron (13 and 133 mg/L) at 400 nm (Use 470 nm.) Chloride at 75 mg/L (Use HCl in vanadate-molybdate reagent.) Only ortho form of phosphate ion is measured (Digest sample.)	Liquors from lime, limestone, dual alkali, and magnesia processes	4.5	0.35	2 (est.)	Spectrophotometer with 1 cm cuvettes

---

[a] Includes labor hours for equipment set up, instrument calibration, reagent preparation and standardization.

[b] Elapsed time from receipt of one sample to calculated final result including sample preparation, analysis, and calculations. Clean-up time is not included. Actual labor hours are less than elapsed time in some cases. Labor hours per sample will be reduced if more than one sample is analyzed.

[c] Coefficient of variation (CV) = (standard deviation/mean) x 100

- When preparing the regenerant solution and HCl (Section 10), be sure to wear safety glasses and work under a hood. Be sure to add acids to an excess of water and allow the solutions to cool before adding additional acid. These steps will prevent acid spattering which may cause severe burns.

9.0 EQUIPMENT AND REAGENTS

Apparatus

- Dionex Model 10, 14, or 16 Ion Chromatograph
- AS3 anion separator column
- AG3 anion guard column
- ASC-2 anion packed-bed suppressor column
- Strip chart recorder with input voltage settings covering the range of 0.1 to 1.0 volt. This voltage range is necessary to optimize the high standard peak height to 85-90% of the chart paper capacity
- Analytical balance accurate to 0.0001 g
- Volumetric flasks (at least one each 50 mL, 100 mL, 200 mL, 250 mL, 500 mL, and 1000 mL)
- Pipettes (1 each 2, 3, 4, 5, 6, 7, 8, and 10 mL for preparing standards and diluting samples)
- Syringes (luer tip, 3.0 mL capacity)
- Engineer's scale for measuring peak heights
- Weigh papers
- Spatula
- Source of air or compressed gas (80 psig minimum)
- Calculator with linear least squares function
- Plastic bottles
- Pipette bulb

- Magnetic stirrer, Corning PC-353 or equivalent
- Magnetic stir bar
- Oven, 120°C, for drying reagents
- Electric timer
- Glass graduated cylinders, 100 mL and 25 mL

Reagents (reagent-grade quality)

- Source of deionized water (conductivity <5 µmhos/cm)
- Sodium fluoride, NaF
- Sodium chloride, NaCl
- Sodium sulfite, Na_2SO_3
- Sodium sulfate, Na_2SO_4
- Potassium sulfate, K_2SO_4
- Disodium hydrogen phosphate, $Na_2HPO_4 \cdot 7H_2O$
- Sodium hydroxide, NaOH
- Sodium carbonate, Na_2CO_3
- Sulfuric acid, H_2SO_4, concentrated
- Hydrochloric acid, HCl, concentrated

Solutions

- Stock fluoride solution, 0.0026 M
- Stock chloride solution, 0.004 M
- Stock sulfite solution, 0.004 M
- Stock sulfate solution, 0.004 M
- Stock phosphate solution, 0.008 M
- Anion standard solutions

- Concentrated modified anion eluent (0.52 M NaOH and 0.70 M Na_2CO_3)
- Working modified anion eluent (0.0013 M NaOH + 0.00175 M Na_2CO_3)
- Regenerant solution (1.0 N H_2SO_4)
- Quality control sample, 0.001 M Cl^- + 0.001 M $SO_4^=$
- Hydrochloric acid (1.0 N)

10.0 SOLUTION/REAGENT PREPARATION

- Stock fluoride solution--Weigh 0.1092 g NaF. Transfer quantitatively to a 1-liter volumetric flask. Add deionized water, mix until all solids have dissolved, and dilute to volume. Store in an airtight polyethylene bottle.

- Stock chloride solution--Weigh 0.2338 g NaCl. Transfer quantitatively to a 1-liter volumetric flask. Add deionized water, mix, dilute to mark. Store in a 1-liter polyethylene or glass bottle.

- Stock sulfite solution--Weigh 0.5044 g Na_2SO_3. Transfer quantitatively to a 1-liter volumetric flask. Add deionized water and 0.02 M (0.6 mL) formaldehyde. Mix until all solids have dissolved. Dilute to volume with deionized water. Prepare fresh daily.

- Stock sulfate solution--Weigh 0.6972 g K_2SO_4. Transfer quantitatively to a 1-liter volumetric flask. Add deionized water, mix, then dilute to volume. Store in a 1-liter polyethylene or glass bottle.

- Stock phosphate solution--Weigh 2.8640 g $Na_2HPO_4 \cdot 7H_2O$. Transfer quantitatively to a 1-liter volumetric flask. Add deionized water, mix, and dilute to volume. Store in a 1-liter polyethylene or glass bottle. [Note: A recent Dionex users' memorandum suggested replacing disodium hydrogen phosphate with anhydrous potassium dihydrogen phosphate (KH_2PO_4) for preparation of phosphate standards. This change is recommended because the hydration value of the disodium hydrogen phosphate is uncertain, (2)].

- Anion standard solutions--Dilute stock solutions as indicated in Table 8.

Table 8

STANDARD SOLUTION PREPARATION GUIDE

	Fluoride		Chloride		Sulfite		Sulfate		Phosphate	
Dilution Volume (mL)	Pipet Volume (mL)	Resulting Concentration of Std (mg/L)	Pipet Volume (mL)	Resulting Concentration of Std. (mg/L)	Pipet Volume (mL)	Resulting Concentration of Std. (mg/L)	Pipet Volume (mL)	Resulting Concentration of Std. (mg/L)	Pipet Volume (mL)	Resulting Concentration of Std. (mg/L)
500	5	0.494	5	1.42	5	3.20	5	3.84	5	7.60
200	5	1.24	5	3.55	4	6.41	4	7.69	3	11.4
100	5	2.47	4	5.67	4	12.8	4	15.4	2	15.2
100	8	3.95	6	8.51	7	22.4	7	26.9	3	22.8

- Concentrated modified anion eluent--Weigh 20.8 g NaOH and 74.2 g Na_2CO_3. Transfer quantitatively to a 1-liter volumetric flask. Add deionized water, mix until all solids have dissolved, then dilute to volume. Store in a 1-liter polyethylene or glass bottle up to two months.

- Working anion eluent--Pipet 10 mL of concentrated modified anion eluent into a plastic Dionex reservoir for 50% strength modified anion eluent and fill to the 4-liter mark. Cap and shake vigorously before removing excess air space from the reservoir. Prepare fresh weekly.

- Regeneration solution--Carefully measure 111 mL concentrated H_2SO_4 by pouring into a glass graduated cylinder. Be sure to wear safety glasses. Work under a hood if possible. Slowly add the acid in 10 mL increments to approximately 3800 mL deionized water in a glass container in a cold water bath. Stir the solution with a glass rod between acid additions. Allow solution to cool before adding more acid. When all acid has been added and the solution has cooled to room temperature, transfer to an eluent reservoir bag. CAUTION: Be certain to add the acid to the water to prevent spattering of acid which will cause severe burns.

- Quality control sample--Weigh 0.0585 g oven-dried (2 hrs at 110°C) NaCl and 0.1421 g oven-dried Na_2SO_4. Transfer to a 1-liter volumetric flask. Add deionized water, mix to dissolve all solids, and dilute to volume. Store in a 1-liter polyethylene or glass bottle.

- 1.0 N hydrochloric acid--Carefully pour 21 mL concentrated HCl into a glass graduated cylinder. Be sure to wear safety glasses and work under a hood. Slowly add the acid to approximately 200 mL deionized water in a 250 mL volumetric flask. Allow solution to cool. Bring volume to the mark with deionized water. CAUTION: Be certain to add the acid to an excess of water (at least 200 mL) to prevent spattering of acid which can cause serious burns.

11.0 QUALITY ASSURANCE/QUALITY CONTROL

Results can be verified by duplicate analyses, analysis of QC standards, analysis of blanks, and analysis of spiked samples. These QC procedures should be implemented with the frequencies in Table 9.

Table 9

QUALITY CONTROL SAMPLE GUIDE

Number of Samples	Number of Full Sets of Standards	Number of Mid Range Standards	Number of Duplicate Analyses	Number of Blanks	Number of QC Standards	Number of Sample Spikes
1-10	2	1	2	1	1	1
11-20	3	2	3	1	1	2
21-40	3	2	4	2	2	3

The directions for preparation of standards and a QC sample are provided in Section 10. Limits should be set (based on precision of the method) for acceptable variations in duplicate measurements and in daily measurements on the QC sample. If measured concentrations fall outside acceptable limits, the possibility of an analytical problem is indicated and the source of the deviation should be identified. If an analytical problem is found, appropriate corrective action should be taken. Sample "spikes" are prepared by adding a known amount of the anion of interest to an aliquot of the sample. The results of analysis of the sample and the spiked sample are compared to determine the "recovery" of the known standard addition. If the amount recovered differs significantly from the amount added, it is concluded that the sample itself (the "matrix") has influenced the results of the analysis. The presence of interfering species should be suspected. If matrix interferences occur, either another analytical method can be used, or the method of standard addition can be applied to determine a correction.

The ion chromatograph should be calibrated for each sample set analyzed. This is accomplished by introducing standard solutions into the instrument according to the procedure outlined in Section 13. There should be a linear relationship between concentration and peak height. (The graph should be a straight line). A least squares curve fit technique should be used to determine the correlation coefficient, which indicates the amount of scatter of the calibration points around the line. Perfect correlation is indicated by a correlation coefficient of 1.0. A calibration line with a correlation coefficient of less than 0.995 is not valid, and a recalibration must be done. (NOTE: If it is obvious that one calibration point is an outlier, reanalyze that point and again check the validity of the calibration.)

12.0 SAMPLE ACQUISITION AND HANDLING

Samples collected from an FGD system can be unstable (supersaturated) and can contain volatile compounds (carbonate and sulfite). To stabilize the sample, the following procedures should be implemented:

1. Separate liquid and solid phases at sample ports using a peristaltic pump and in-line nucleopore filter.

2. Filter the liquor directly into a preweighed solution of deionized water containing formaldehyde at 5 times the molarity of the expected aqueous sulfite concentration.

Separation of liquids and solids will prevent dissolution or precipitation which would change the composition of the liquid or solid. Formaldehyde addition will inhibit sulfite oxidation to sulfate. Sulfite can then be measured directly in the same sample as the other ions, instead of oxidizing it to sulfate and measuring "total sulfur". If this sample acquisition procedure is followed, the samples will be ready for immediate analysis. They also can be stored for analysis at a later date without additional preservation.

When diluting samples, it is necessary to calculate a sampling dilution factor. This value should be used to correct the analytical results for the dilution effect. It can be calculated using the following equation:

$$DF = \frac{\frac{W_3 - W_2}{SG} + W_2 - W_1}{\frac{W_3 - W_2}{SG}}$$

where: DF = sampling dilution factor (dimensionless),

W_1 = weight of empty sample container (g),

W_2 = weight of sample container and dilution solution (g),

W_3 = weight of sample containter, dilution solution, and sample (g), and

SG = specific gravity of the sample.

If the specific gravity of the liquor sample is not known, a value of 1.0 may be used without serious error in many cases. The magnitude of the error will be greater the higher the dissolved solids concentration (refer to volume 1 of handbook). If a specific gravity of 1.00 is used, the dilution factor equation reduces to:

$$DF = \frac{W_3 - W_1}{W_3 - W_2}$$

Every attempt should be made to use the actual specific gravity for high TDS liquors since deviation of the sample density from 1 will cause error in the calculated dilution factor and all analytical results. Specific gravity can be measured easily using Method 10.

Solid samples must be prepared by the procedure outlined below.

Preparation of Solid Samples by Acid Dissolution

1. Weigh approximately 0.5 g of dry solids to the nearest 0.0001 g and record the weight.

2. Quantitatively transfer the weighed solids to a 250 mL volumetric flask containing approximately 100 mL water and a magnetic stir bar.

3. Add 3 mL 30% hydrogen peroxide to the flask, cap, and place on a magnetic stir plate. Stir for 5 minutes. The flask should be inverted intermittently during this time.

4. Add 20 mL of 1.0 N HCl, cap, and stir for 30-35 minutes.

5. After stirring, remove the stir bar from the flask and bring to volume with deionized water.

6. Assemble a filter apparatus containing a weighed filter membrane with a pore size of 0.45 µm.

7. Rinse the filter holder and filtration flask twice by drawing small aliquots of the sample through the filter and swirling in the filtration flask. Discard this filtrate. The remaining dissolution should then be filtered without rinsing either the volumetric flask or filter holder.

8. Transfer the filtrate to a clean, dry sample bottle and label accordingly.

9. Analyze for total sulfur as sulfate by ion chromatography using the method for liquid samples (Section 13).

10. The acid-insoluble ("inerts") portion of the solid sample can be measured by drying and weighing the filter plus solids obtained in Step 7.

13.0 STEPWISE PROCEDURE

Instrument Set-Up

1. Turn on the ion chromatograph power switch.

2. Turn on the air to the ion chromatograph, at least 80 psi, and check to be certain the air line is free of water.

3. Check to be certain all eluent reservoirs are open, and that the DI water reservoir is full.

4. Start the eluent pump on deionized water and flush the plumbing system for 10 minutes at 33% flow.

5. Change to the anion eluent and flush the plumbing system 10 minutes.

6. Switch the separator and suppressor columns in line.

7. Check the pressure; if it is greater than 650 psi, reduce the flow rate.

8. Visually inspect the columns and fittings for leaks.

9. If system pressure is below 150 psi with columns in line, switch columns out of line and disconnect the pump's bubble trap inlet to allow air bubbles to escape. Reconnect the bubble trap and switch columns back in line.

10. Allow the system to stabilize for about 15 minutes.

11. Set full-scale on the conductivity meter to 30 μmhos.

12. Turn the mode switch to linear.

13. Set the conductivity to zero using the offset control.

14. Turn on the recorder at 0.5 V input voltage and 30 cm/hr chart speed.

15. Adjust the recorder zero to 5% of full scale.

16. Watch the recorder trace for a stable baseline.

17. Reset the offset control if necessary.

18. Analyses can begin when the baseline is stable (5-10 minutes).

19. When peaks do not return to baseline before elution of the next species, baselines should be drawn in as in Figure 1.

Instrument Calibration

1. Set the inject/load switch to the load position.

2. Flush a 3 mL syringe with the highest concentration standard.

3. Flush the sample loop with 3 mL of the highest standard.

4. Introduce a second 3 mL portion and flip the switch to the inject mode. Press the pip button to mark the point of injection on the chart paper.

5. After a minute or two, flip the injection switch back to the load position.

6. Watch the recorder trace, noting the elution time of the peaks and the height of the peaks. If the peak is less than 1/2 of the chart paper in height, switch the recorder to 0.2 V input; if the peak is off scale, switch the input voltage to one volt. Some recorders have a fine adjustment control which allows the peak height to be adjusted more precisely. 85-90% of the chart height is a good height for the high standard.

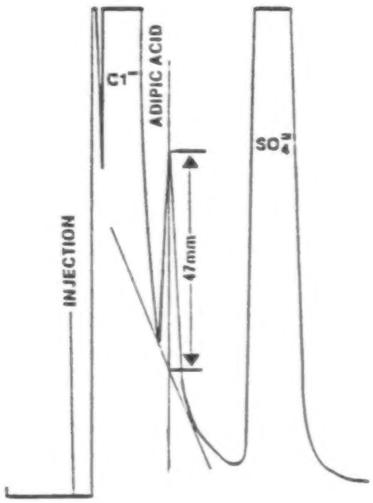


Figure 1. Peak Height Measurement on a Partially Resolved Ion Chromatography Peak

7. Repeat Steps 2 through 5 for the other standards and a blank.

8. From the instrument response (peak height) during analysis of the blanks and calibration standards, determine the correlation coefficient of the calibration curve using a least square curve fit technique (refer to volume 1 of handbook). An acceptable calibration curve should have a correlation coefficient of no less than 0.9950. Or, plot the calibration curve on a sheet of linear graph paper. Plot the standard concentration (mg/L) on the x-axis (horizontally) and peak height on the y-axis (vertically). After the four points (one per standard) have been marked on the graph, draw a straight line passing as close as possible to every point. This line represents the standard curve. To determine the concentration of an analyzed sample, find its peak height on the vertical axis, move to the right in a straight line until you reach the standard curve, then read the concentration from the horizontal axis directly below the point on the standard curve. If the linear least squares curve fit technique has been used, the concentration in the unknown sample is calculated from the peak height and the slope and intercept of the calibration line (refer to volume 1 of handbook).

Sample Analysis

1. Once an acceptable calibration has been obtained, repeat Steps 2 through 5 described above for instrument calibration for the samples, QC standards and spiked samples.

2. If necessary, dilute the sample so that it is in the same concentration range as the standards. Record both the original sample volume, V_P, and the diluted volume, V_T, on the data recording form (Figure 3, Section 14). If the concentrations of the anions in a sample vary widely, it may be necessary to perform a separate dilution and injection for each anion. In typical scrubber liquors, chloride and sulfate can be analyzed in one dilution, and another is required for fluoride, sulfite and phosphate.

3. When analyzing samples, wait until all peaks have eluted before injecting the next sample.

4. Record the sample number or standard identification and sampling dilution factor, DF, on the strip chart by the pip mark and on the data recording form.

5. Run quality control samples as required (see Table 9). Quality control samples should be interspersed with other samples.

Instrument Shutdown

1. Turn the mode switch to zero and switch the eluent to water. Run water through the anion system for 20 minutes.

2. Bypass both columns by turning the switches to the down position.

3. Turn the eluent pump off and empty the waste container as necessary.

4. If the unit has been run for 8 to 10 hours, regenerate the suppressor column.

Regeneration of the Suppressor Column

1. Make up 4 liters of 1 N H_2SO_4 regenerant solution according to the directions in Section 10. Rinse a 4-liter reservoir with several small aliquots of the regenerant. Fill the reservoir with the regenerant and attach to the system regenerant connection. Open the reservoir.

2. Set regeneration time at 15 minutes and the rinse time at 35 minutes.

3. Press the green "start" button. The instrument will run through the regeneration cycle and turn off automatically. The air must be left on until the regeneration cycle is completed.

14.0 DATA RECORDING FORM

Figures 2, 3, and 4 show data recording forms for instrument calibration and liquid and solid sample analysis.

15.0 DATA REDUCTION AND CALCULATIONS

Accurately measure peak heights on chart paper using an engineer's scale. (The scale with 50 subdivisions per inch should be used.) Record the number of height units for each standard or sample on the data recording form.

Use the peak heights for standards and blanks (Figure 2) to plot a calibration line, or use a linear least square curve fit technique to calculate slope, intercept and correlation coefficient.

Laboratory Name: ____________________

Analysis Date: ____________________

Analyst Initials: ____________________

Instrument: ____________________

				Calibration Data			Instrument Conditions			
Standard I.D.	Analyte	Theoretical Injected Concentration (mg/L)	Peak Height	Slope	Intercept	Correlation Coefficient	Offset	Voltage Input	Flow Rate	μmhos/cm
1.										
2.										
3.										
4.										

Figure 2. Ion Chromatography Calibration Data Recording Form.

Laboratory Name: ____________________ **Analyst Initials:** ____________________

Analysis Date: ____________________ **Instrument:** ____________________

Sample I.D.	Analyte	Peak Height	C_G Concentration In Injected Sample (mg/L)	DF Sampling Dilution Factor	V_P Original Sample Volume (mL)	V_T Diluted Sample Volume (mL)	C_L Concentration In Original Liquid Sample (mg/L)
1.							
2.							
3.							
4.							

$$C_L = C_G \left(\frac{V_T}{V_P} \right) DF$$

Figure 3. Ion Chromatography Data Recording Form for Liquid Samples.

Laboratory Name: ______________________ Analyst Initials: ______________________

Analysis Date: ______________________ Instrument: ______________________

Sample I.D.	Analyte	Peak Height	C_G Concentration In Injected Sample (mg/L)	V_S Dissolution Volume (mg/L)	W Weight of Solid Sample (g)	C_S Concentration In Original Solid Sample (mg/g)
1.						
2.						
3.						
4.						

$$C_S = \frac{V_S C_G}{1000\ W}$$

Figure 4. Ion Chromatography Data Recording Form for Solid Samples.

For each sample peak height recorded on Figure 3 or 4, read the anion concentration in the injected sample, C_G, from the calibration plot, or calculate it from the slope and intercept of the calibration line.

Calculate the concentration in the original liquid sample using the following equation:

$$C_L = C_G \left(\frac{V_T}{V_P}\right) DF$$

where:
C_L = concentration in original liquid (mg/L),
C_G = concentration in injected sample read or calculated from calibration data (mg/L),
V_T = volume sample was diluted to in the laboratory (mL),
V_P = volume of original sample taken for analysis (mL), and
DF = sampling dilution factor calculated as described under "Sample Acquisition and Handling" (dimensionless).

Calculate the concentration in the original solid sample using the following equation:

$$C_S = \frac{C_G V_S}{1000 W}$$

where:
C_S = concentration in the original solid (mg/g),
C_G = concentration in injected sample from calibration data (mg/L),
V_S = dissolution volume (volume to which original solid sample was dissolved, mL), and
W = weight of solid sample (g).

The 1000 factor in the denominator is used to convert mL to L. To express the results for solid samples in weight percent, divide C_S by 10.

16.0 PRECISION AND BIAS

The precision and bias of this ion chromatography procedure have been investigated (refer to volume 1 of handbook). The procedure given in Section 13 was used to analyze fluoride, chloride, sulfite, sulfate, and phosphate in synthetic scrubber liquors and total sulfur in solids obtained from two operating lime FGD systems. The synthetic liquors were prepared from reagent grade chemicals with compositions typical of scrubbing liquors from lime, limestone, magnesia and dual alkali scrubbing processes. The linear least squares curve fit technique was used to prepare calibration curves.

Table 10 gives the results of determination of single operator precision and bias for fluoride analysis in five synthetic scrubber liquors, all containing about the same level (4-10 mg/L) of fluoride. The pooled coefficient of variation for all materials tested was 14.9 percent. The percent bias based on known amounts of fluoride added to the solutions ranged from -12 to +72 percent. Statistically significant bias was found for all types of scrubber liquors.

Fluoride peak resolution is affected by high sulfate and chloride concentrations. Table 11 shows how both precision and bias are affected by high chloride-to-fluoride and high sulfate-to-fluoride mole ratios. The highest coefficients of variation and the largest bias were found for solutions with high sulfate-to-fluoride and/or high chloride-to-fluoride ratios.

The results in Table 11 indicate that care should be used in applying this method to liquors from high TDS limestone, dual alkali, or magnesia scrubbing systems which typically contain high levels of sulfate and chloride.

Table 12 gives the results of determination of single operator precision and bias for chloride analysis in five synthetic scrubber liquors and a standard made from sodium chloride in deionized water. The pooled coefficient of variation for all materials tested is 12.3 percent. The percent bias based on known amounts of chloride added to the solutions ranged from -4.8 to 8.4

Table 10

RESULTS OF INVESTIGATION OF PRECISION AND BIAS OF FLUORIDE ANALYSIS BY ION CHROMATOGRAPHY WITH MODIFIED ANION EFFLUENT

Sample ID and Description[1]	True Value[2] (mg/L)	n = number of Replicates[3]	Mean of Measurements (mg/L)	Precision[4] Standard Deviation (mg/L)	Precision[4] Coefficient of Variation (%)	Bias[5] (%)
LQ5-High TDS limestone scrubber liquor	3.95	8	5.3	0.91	17.	34.
LQ4-Low TDS limestone scrubber liquor	4.94	8	4.8	0.09	1.9	-3.4
LQ1-High magnesium lime scrubber liquor	5.93	8	5.2	0.19	3.6	-12
LQ2-Magnesia (high Mg) scrubber liquor	7.98	8	13.7	3.8	27.	72
LQ3-Dual alkali scrubber liquor	9.88	8	12.4	1.1	8.6	26

---

[1] Sample ID

	Composition (mg/L)							
	Ca	Mg	Na	SO_4	CO_3	Cl	F	SO_3
LQ1	400	1,215	385	6,144	30	284	5.93	80
LQ2	160	36,500	1,200	146,000	120	285	7.98	
LQ3	40	122	45,800	48,000	36,000	14,300	9.88	
LQ4	561	243	647	2,570	300	600	4.94	160
LQ5	20,000	608	238	768	6	35,800	3.95	

[2] Known amount of reagent grade chemicals added to deionized water

[3] Number of times a separate sample of the same material was analyzed by the same analyst with the same instrument and a separate calibration

[4] Standard deviation = $[\sum (X_i - \bar{X})^2/n-1]^{1/2}$

Coefficient of variation = (standard deviation/mean) x 100

[5] Bias = [(mean - true value)/true value] x 100

[6] Not statistically significant at the 0.95 level of confidence

Table 11

EFFECT OF CHLORIDE AND SULFATE ON PRECISION AND BIAS OF ANALYSIS OF 4-10 MG/L FLUORIDE IN SYNTHETIC SCRUBBER LIQUORS

Scrubber Liquor	Mole Sulfate Mole Fluoride	Mole Chloride Mole Fluoride	Coefficient of Variation (%)	Bias (%)
LQ1-High magnesium lime scrubber liquor	200	26	4	-12
LQ2-Magnesia (high Mg) scrubber liquor	2,000	9	27	72
LQ3-Dual alkali scrubber liquor	1,000	800	9	26
LQ4-Low TDS limestone scrubber liquor	100	60	2	-3.4
LQ5-High TDS limestone scrubber liquor	40	5,000	17	34

Table 12

RESULTS OF INVESTIGATION OF PRECISION AND BIAS OF CHLORIDE ANALYSIS BY ION CHROMATOGRAPHY WITH MODIFIED ANION ELUENT

Sample ID and Description[1]	True Value[2] (mg/L)	n = number of Replicates[3]	Mean of Measurements (mg/L)	Precision[4] Standard Deviation (mg/L)	Precision[4] Coefficient of Variation (%)	Bias[5] (%)
QCAB-NaCl in deionized water	35.5	8	34.0	1.4	4.2	1.9*
LQ1-High magnesium lime scrubber liquor	284.	7	276	4.6	1.7	-2.7
LQ2-Magnesia (high Mg) scrubber liquor	285	8	309	84	27.	8.4*
LQ4-Low TDS limestone scrubber liquor	603	8	575	61	11	-4.7*
LQ3-Dual alkali scrubber liquor	14,300	8	13,600	543	4.0	-4.8
LQ5-High TDS limestone scrubber liquor	35,800	8	37,200	854	2.3	3.9

---

[1] Sample ID — Composition (mg/L)

	Ca	Mg	Na	SO_4	CO_3	Cl
LQ1	400	1,215	379	6,144	30	284
LQ2	160	36,500	1,200	146,000	120	285
LQ3	40	122	45,800	48,000	36,000	14,300
LQ4	561	243	643	2,570	300	600
LQ5	20,000	608	237	768	6	35,800

[2] Known amount of reagent grade chemicals added to deionized water

[3] Number of times a separate sample of the same material was analyzed by the same analyst with the same instrument and a separate calibration

[4] Standard deviation = $[\sum (X_i - \bar{X})^2/n-1]^{1/2}$

Coefficient of variation = (standard deviation/mean) x 100

[5] Bias = [(mean - true value)/true value] x 100

*Not statistically significant at the 0.95 level of confidence

percent. No statistically significant bias was found for the sodium chloride sample, the low TDS limestone or the magnesia scrubbing liquor. The highest bias and coefficient of variation were found for the high magnesium scrubbing liquor, which has the highest sulfate to chloride ratio of the solutions tested. However there does not appear to be a significant correlation between sulfate to chloride ratio and precision and bias in the other samples.

Table 13 shows the single operator precision and bias for sulfite analysis in the five liquors and a sample prepared from sodium sulfite in deionized water. The sulfite concentration in the samples ranged from 8 to 40,000 mg/L. The pooled coefficient of variation for all materials tested is 11.4 percent, but this is a misleading precision limit since the precision is concentration dependent. The pooled coefficient of variation for solutions containing 80 to 40,000 mg/L sulfite is 2.5 percent.

The percent bias based on known amounts of sulfite added ranged from -1.7 to 72 percent. The bias was not statistically significant for the two samples with the highest sulfite concentrations. Bias was positive (indicating high recovery) for all samples with significant bias.

Table 14 shows that precision and bias clearly depend on sulfite concentration, and that the method is much more accurate when applied to liquors with high sulfite concentrations. High sulfate concentration hinders sulfite peak separation and contributes to the poor accuracy in low-sulfite liquors. This method is not accurate for sulfite analysis in high TDS or forced oxidized systems where sulfate levels are much higher than sulfite levels. It is applicable in high magnesium lime, magnesia, dual alkali and low TDS limestone systems.

Table 15 gives results of determination of the single operator precision and bias for sulfate analysis in five scrubber liquors and a sample prepared from potassium sulfate in deionized water. The sulfate concentration in the scrubber liquors ranged from 770 to 146,000 mg/L. The pooled coefficient of variation for all materials tested is 3.7 percent. The percent

Table 13

RESULTS OF INVESTIGATION OF PRECISION AND BIAS OF SULFATE ANALYSIS BY ION CHROMATOGRAPHY WITH MODIFIED ANION ELUENT

Sample ID and Description[1]	True Value[2] (mg/L)	n = number of Replicates[3]	Mean of Measurements (mg/L)	Precision[4] Standard Deviation (mg/L)	Precision[4] Coefficient of Variation (%)	Bias[5] (%)
LQ5-High TDS limestone scrubber liquor	8.01	5	13.8	4.4	33.	72
QCAB-Sodium sulfite in deionized water	9.88	8	12.4	1.1	8.7	26
LQ1-High magnesium lime scrubber liquor	80.1	8	88.7	2.7	3.0	11
LQ4-Low TDS limestone scrubber liquor	160	7	171	5.1	3.0	6.4
LQ2-Magnesia (high Mg) scrubber liquor	2,400	7	2,430	53	2.2	0.9*
LQ3-Dual alkali scrubber liquor	39,700	8	39,000	860	2.2	-1.7*

---

[1] Sample ID

	Composition (mg/L)								
	Ca	Mg	Na	SO_4	CO_3	Cl	F	SO_3	PO_4
LQ1	400	1,215	385	6,144	30	284	5.93	80	0
LQ2	160	36,500	1,200	146,000	120	285	0	2,400	0
LQ3	40	122	45,800	48,000	36,000	14,300	0	39,700	0
LQ4	561	243	647	2,570	300	600	4.94	160	53.2
LQ5	20,000	608	239	768	6	35,800	0	8.01	0

[2] Known amount of reagent grade chemicals added to deionized water

[3] Number of times a separate sample of the same material was analyzed by the same analyst with the same instrument and a separate calibration

[4] Standard deviation = $[\sum (X_i - \bar{X})^2/n-1]^{1/2}$

Coefficient of variation = (standard deviation/mean) x 100

[5] Bias = [(mean - true value)/true value] x 100

*Not statistically significant at the 0.95 level of confidence

Table 14

EFFECT OF SULFITE CONCENTRATION AND SULFATE-SULFITE MOLE RATIO ON PRECISION AND BIAS OF SULFITE ANALYSIS BY ION CHROMATOGRAPHY

Sulfite Concentration (mg/L)	$\frac{\text{Moles } SO_4}{\text{Moles } SO_3}$	Coefficient of Variation (%)	Bias (%)
8	80	32	72
10	0	9	26
80	64	3	11
160	14	3	6
2,400	50	2	0.9*
40,000	1	2	-1.7*

---

*Not statistically significant

Table 15

RESULTS OF INVESTIGATION OF PRECISION AND BIAS OF SULFATE ANALYSIS BY ION CHROMATOGRAPHY WITH MODIFIED ANION ELUENT

Sample ID and Description[1]	True Value[2] (mg/L)	n = number of Replicates[3]	Mean of Measurements (mg/L)	Precision[4] Standard Deviation (mg/L)	Precision[4] Coefficient of Variation (%)	Bias[5] (%)
QCAB-sodium sulfate in deionized water	96.1	8	95.4	2.9	3.0	-0.8*
LQ5-High TDS limestone scrubber liquor	768	8	745	50	6.6	-3.0*
LQ4-Low TDS limestone scrubber liquor	2,570	8	2,800	70	2.5	8.8
LQ1-High magnesium lime scrubber liquor	6,150	8	6,110	47	0.8	-0.6*
LQ3-Dual alkali scrubber liquor	48,000	8	47,500	1,800	3.8	-1.0*
LQ2-Magnesia (high Mg) scrubber liquor	146,400	8	146,400	4,500	3.1	0*

---

[1] Sample ID

	Composition (mg/L)					
	Ca	Mg	Na	SO_4	CO_3	Cl
LQ1	400	1,215	379	6,144	30	284
LQ2	160	36,500	1,200	146,000	120	285
LQ3	40	122	45,800	48,000	36,000	14,300
LQ4	561	243	643	2,570	300	600
LQ5	20,000	608	237	768	6	35,800

[2] Known amount of reagent grade chemicals added to deionized water

[3] Number of times a separate sample of the same material was analyzed by the same analyst with the same instrument and a separate calibration

[4] Standard deviation = $[\sum (X_i - \bar{X})^2/n-1]^{1/2}$

Coefficient of variation = (standard deviation/mean) x 100

[5] Bias = [(mean - true value)/true value] x 100

*Not statistically significant at the 0.95 level of confidence

bias based on known amounts of sulfate added to the solutions ranged from -3 to 8.8; however, statistically significant bias was found only for the low TDS limestone scrubber liquor. The cause of the unusually high bias for this sample is not apparent.

Table 16 shows single operator precision and bias for phosphate analysis in two scrubber liquors at a level of 50 to 60 mg/L. Phosphate potentially could be present in scrubber liquors if cooling water blowdown were used for make up in closed loop systems. The level to which phosphate would build up is limited by the solubility of its calcium and magnesium salts, but there are no data to indicate typical levels in scrubber liquors. (The phosphate concentration in natural waters is on the order of 30 mg/L.)

Phosphate peak resolution was not possible in synthetic scrubber liquors with high chloride and/or sulfate concentrations. Resolution was achieved in the high-magnesium lime liquor and the low TDS limestone liquor. The pooled coefficient of variation for both materials was 20 percent. The bias was not statistically significant for either sample.

Table 17 shows precision data for analysis of total sulfur (sulfite plus sulfate) in solid samples containing 20 to 50 weight percent total sulfate (200-500 mg SO_4/g). The samples were obtained from two lime FGD systems, one employing a scrubber and the other a spray dryer. They were dissolved and oxidized using the procedure in Section 12 and analyzed using the procedure in Section 13. The single operator coefficient of variation for both materials is 4.1 percent. Therefore, the results of two properly conducted analyses by the same analyst on the same material should not differ by more than 11.6 percent of their average.

Table 18 summarizes the precision limits for all anions in samples containing calcium, magnesium, sodium, chloride, fluoride, phosphate, sulfite and sulfate. The results of two properly conducted analyses for an anion by

Table 16

RESULTS OF INVESTIGATION OF PRECISION AND BIAS OF PHOSPHATE ANALYSIS BY ION CHROMATOGRAPHY WITH MODIFIED ANION ELUENT

Sample ID and Description[1]	True Value[2] (mg/L)	n = number of Replicates[3]	Mean of Measurements (mg/L)	Precision[4] Standard Deviation (mg/L)	Precision[4] Coefficient of Variation (%)	Bias[5] (%)
LQ4-' w TDS limestone scrubber liquor	60.8	8	61.4	4.7	7.6	1.0*
LQ1-High magnesium lime scrubber liquor	53.2	8	57.0	15	27	7.3*

---

[1] Sample ID

	Composition (mg/L)								
	Ca	Mg	Na	SO_4	CO_3	Cl	F	SO_3	PO_4
LQ1	400	1,215	385	6,144	30	284			60.8
LQ2	160	36,500	1,200	146,000	120	285	7.98	2400	0
LQ3	40	122	45,800	48,000	36,000	14,300	9.88	39700	0
LQ4	561	243	647	2,570	300	600	4.94	160	53.2
LQ5	20,000	608	238	768	6	35,800	3.95	8.07	0

[2] Known amount of reagent grade chemicals added to deioiozed water

[3] Number of times a separate sample of the same material was analyzed by the same analyst with the same instrument and a separate calibration

[4] Standard deviation = $[\sum (X_i - \bar{X})^2/n-1]^{1/2}$

Coefficient of variation = (standard deviation/mean) x 100

[5] Bias = [(mean - true value)/true value] x 100

*Not statistically significant at the 0.95 level of confidence

Table 17

RESULTS OF INVESTIGATION OF PRECISION OF TOTAL SULFUR ANALYSIS IN SCRUBBER SOLIDS BY ION CHROMATOGRAPHY WITH MODIFIED ANION ELUENT

Sample ID and Description	n = number of Replicates[1]	Mean of Measurements (mg/g)	Precision[2] Standard Deviation (mg/g)	Precision[2] Coefficient of Variation (%)
SL1-Lime spray dryer solids with 80% fly ash	8	226	11	5.1
SL1-Lime scrubber solids without fly ash	8	508	14	2.8

---

[1] Number of times a separate sample was analyzed by the same analyst with the same instrument and a separate calibration

[2] Standard deviation = $[\sum (X_i - \bar{X})^2/n-1]^{1/2}$

Coefficient of variation = (standard deviation/mean) x 100

Table 18

SUMMARY OF PRECISION LIMITS FOR ANALYSIS OF ANIONS BY ION CHROMATOGRAPHY WITH MODIFIED ANION ELUENT

Anion	Concentration Range (mg/L)	One Sigma Limit (Single Operator Coefficient of Variation) (1S%)	Difference Two Sigma Limit (D2S%)
Fluoride	4-10	14.9	42.2
Chloride	36-36,000	12.3	34.8
Sulfate	100-146,000	3.7	10.5
Sulfite	80-40,000	2.5	7.1
Phosphate	50-60	19.0	53.8

---

[1] These numbers represent the (1S%) and (D2S%) limits as described in ASTM Practice C670-81 for preparing precision statements for test methods for construction materials.

the same analyst on the same material using the same instrument should not differ by more than the percent of their average listed in the last column of Table 18.

17.0 REFERENCES

1. A. E. Behl. Radian Laboratory Notebook No. 000181. September 1982.
2. Ion Chromatograph Models 10 and 14 Operation and Maintenance Manual. Sunnyvale, CA: Dionex Corporation, 1979.
3. J. C. Terry and E. E. Ellsworth. IC Analysis of Formaldehyde Stabilized Sulfite Solutions. Radian Corporation In-House Study Project DCN 80-290-403-07-12-01, October 1980.
4. L. J. Holcombe and F. B. Meserole. Applications of Ion Chromatography for the Analysis of Utility Waste Liquors and Leachates. Radian Corporation paper presented at the 35th ACS Southwest Regional Meeting, December 1979.
5. L. J. Holcombe and J. C. Terry. Application of Ion Chromatography for the Analysis of Lime/Limestone Based SO_2 Scrubber Solutions. Radian Corporation Technical Note DCN 78-320-403-02, March 1978.

44. Analysis of Carbonate in Scrubber Liquor, Scrubber Solids and Limestone by Non-Dispersive Infrared (NDIR) Absorption Spectrophotometry

1.0 DESCRIPTION OF METHOD

A sample containing carbonate in aqueous solution is injected into an acid pool reactor where CO_2 is formed. The CO_2 is carried by a purge gas stream (N_2) to an absorption cell detector. The detector compares the absorbance of infrared radiation by the CO_2 from the sample with that of an identical cell containing pure N_2 at the frequency specific for CO_2.

The procedure outlined here is for an Oceanography International Total Carbon Analyzer. If another analyzer is used, consult the instrument manual for operating instructions.

2.0 SIGNIFICANCE AND USE

This method can be used to determine carbonate in limestone and solid and liquid FGD samples. It was developed as a "referee" method in an early study of analytical methods for lime/limestone scrubbing (3). The method is elaborate and requires time-consuming equipment calibration, solids preparation and standards preparation. However it is the best method for carbonate analysis if many samples are to be analyzed and carbonate (rather than total alkalinity) must be measured.

3.0 DETECTION LIMIT AND RANGE OF METHOD

Detection limit: 1 μg CO_3

Applicable range of procedure: 2 to 10 μg CO_3

4.0 ELAPSED TIME AND LABOR HOURS REQUIRED

Elapsed time from sample receipt to final answer: 5.5 hr (as indicated below assuming instrument is warm)

Instrument warm-up, span and zero adjustment: 5 hr

Syringe calibration: 1 hr/week

Operator/analyst time: 1.6 hr (not including reagent or standards preparation)

Activity	Elapsed Time (Hours)	Analyst Labor (Hours)
Standards/solution reagent preparation	2.0	2.0
Solid sample preparation	2.5	0.50
Instrument calibration	0.75	0.75
Sample analysis	0.10	0.10
Calculations	0.20	0.20

5.0 DEFINITIONS

infrared absorption spectrophotometry--involves the twisting, binding, rotating, and vibrating motions of atoms in a molecule. Incident radiation is absorbed at specific wavelengths depending on the functional groups in the molecule. The amount of radiation absorbed is proportional to the concentration.

acid pool reactor--a small ampule or chamber fitted with a septum and having an opening through which a stream of nitrogen is introduced. The ampule is filled with an acid mixture and injected with a sample containing carbonate. The liberated carbon dioxide is swept out by the nitrogen stream.

6.0 INTERFERENCES

SO_2, NO, NO_2 and H_2O all absorb radiation at the same wavelength as CO_2, so provisions are made to eliminate interference from these species. Hydrogen peroxide is added to the solution in the acid pool reactor to oxidize sulfite to sulfate. Phosphoric acid and potassium dihydrogen phosphate prevent stripping of NO and NO_2 (but not CO_2) if nitrite or nitrate are present. Water vapor is removed by adsorption on anhydrone.

7.0 ALTERNATE METHODS

A wet chemical method for carbonate (CO_2 evolution and absorption) is also included in this handbook. The choice of method depends on the time required, available equipment, and the required accuracy. These elements are summarized in Table 1 for the carbonate methods included in this handbook.

8.0 PRECAUTIONS/CRITICAL STEPS

The pH of the solution in the acid pool reactor must be less than about 5.6 for the complete reaction of carbonate and liberation/stripping of CO_2 to occur. The ideal operating pH is 4.3. Methyl red indicator is used to monitor the pH in the acid pool reactor. This indicator is red at pH 4.2,

Table 1

CARBONATE METHODS COMPARISON

Method	Range	Interferences/ Sources of Bias	Applications	Preparation Time[a] (hr)	Sample Analysis Time[b] (hr/single sample)	Single Operator Coefficient of Variation[c] (%)	Special Equipment Requirements
NDIR Absorption Spectrophotometry	2 to 10 μg CO_2	Sulfite (oxidize with peroxide) Nitrate and nitrite (add phosphoric acid and KH_2PO_4) Water vapor (adsorb onto anhydrone)	Limestones; solid and liquid FGD samples	5.25	0.30	Liquors 4.0 Limestones 5.3 Scrubber Solids 8.4	Non-dispersive infrared analyzer with integrator Standardization vial Syringes
CO_2 Evolution Barium Hydroxide Absorption	2,000 to 20,000 μg CO_2	Nitrate (acidify to pH 3) Nitrite (add sulfonic acid at pH 2.5) Sulfite (oxidize with peroxide)	Limestones; solid and liquid samples from lime, limestone, magnesia, and dual alkali FGD systems	2.0	1.2	Liquors 4.8 (120-36,000 mg/l) Limestones 2.7 Scrubber Solids 9.0	Burets Special glassware (refer to Equipment and Reagents Section)
Alkalinity by Acid/Base Titration	2 to 100 percent $CaCO_3$	Sulfite (oxidize with peroxide)	Carbonate in limestones; total alkalinity in scrubber solids	3.0	0.7	Synthetic Liquors 3.8 Limestones 2.0 Scrubber Solids 7.5	Buret

---

[a] Includes labor hours for equipment set up, instrument calibration, reagent preparation and standardization

[b] Elapsed time from receipt of one sample to calculated final result including sample preparation, analysis, and calculations. Clean-up time is not included. Actual labor hours are less than elapsed time in some cases. Labor hours per sample will be reduced if more than one sample is analyzed.

[c] Coefficient of variation (CV) = (standard deviation/mean) x 100

light orange at pH 5.6 and yellow at pH 6.2. When the solution in the acid pool reactor is spent, it appears light orange and must be replaced.

The length of the digestion/dissolution step for solid samples is critical. A study of precision and bias of this method with four limestone samples and a sample of reagent grade calcium carbonate showed that a sample digestion period of 10 minutes was inadequate. Carbonate recovery was 15 to 21 percent low compared to recovery obtained with a 60 minute digestion period.

A digital integrator or a strip chart integrator should be used to determine peak area. Peak height is not an accurate measure of instrument response, since it varies with pH of the solution in the acid pool reactor. Peak area is independent of the acid pool pH.

9.0 EQUIPMENT AND REAGENTS

Apparatus

- Oceanography International Total Carbon System (or equivalent) non-dispersive infrared analyzer with digital or strip chart integrator
- Standardization vial (OIC No. M 125) used as acid pool reactor and for syringe calibration
- Analytical balance, accurate to 0.0001 g
- Hamilton Syringe No. CR-700-200 (or equivalent), 200 μL capacity
- 25 mL syringe
- Volumetric glassware (pipettes and flasks)
- Drying tubes and glass wool
- Ultrasonic bath (optional)

- 40 mL disposable septum sample bottles for dissolving solid samples (bottles - Wheaton No. 224833, caps - Wheaton No. 240517, disposable liners - Wheaton No. 240587)
- Oven for drying reagents 400°C
- Glass graduated cylinder, 10 mL

Reagents

- Sodium carbonate, Na_2CO_3
- Hydrogen peroxide, H_2O_2
- Potassium dihydrogen phosphate, KH_2PO_4
- Phosphoric acid, H_3PO_4
- Methyl red indicator
- Ammonium hydroxide, NH_4OH
- Anhydrous magnesium perchlorate, (anhydrone) $Mg(ClO_4)_2$
- Ammonium chloride, NH_4Cl
- Disodium EDTA, Na_2EDTA
- Hydrochloric acid, HCl (concentrated, 12.1 N)

10.0 SOLUTION/REAGENT PREPARATION

- Standard CO_2 solution, 100 mg/L--Dry approximately 0.5 g reagent grade anhydrous Na_2CO_3 at 400°C for at least 1 hour. Dissolve 0.0442 g in CO_2 free water and dilute to 250 mL in a volumetric flask. Store in an inverted flask fitted with an injection stopper and protected with ascarite (soda-asbestos) or soda-lime tubes.
- Potassium dihydrogen phosphate solution, 10%--Dissolve 100 g reagent grade KH_2PO_4 in deionized water and dilute to one liter in a volumetric flask. This solution is a component of the acid pool reactor solution.
- Methyl red indicator--Dissolve 0.1 g crystalline methyl red indicator in 100 mL deionized water. This indicator is added to the acid pool reactor solution.

- Anhydrous magnesium perchlorate--This material is used as a desiccant in the drying tubes.

- Buffer preservative solution--Dissolve 35.0 g NH_4Cl in 285 mL fresh NH_4OH and dilute to 500 mL with deionized water. Weigh 365 g Na_2EDTA in a separate container and add to the NH_4OH-NH_4Cl solution. This makes approximately 700 mL. This solution is used to preserve both liquid and dissolved solid samples.

- Phosphoric acid solution, 5%--Dilute 50 mL concentrated H_3PO_4 to one liter with deionized water. CAUTION: Always add concentrated acid to an excess of water, never the reverse. Use extreme caution when handling this or any other acid. The phosphoric acid is used in the acid pool reactor.

- Hydrochloric acid, 1 N--Measure 9.3 mL concentrated (12.1 N) HCl in a graduated cylinder. Slowly add to 100 mL of CO_2-free deionized water. This solution is used to dissolve solid samples.

- Acid reactor working solution--Add to 95 mL of 10% KH_2PO_4 solution, 5 mL 5% H_3PO_4, 2 mL 30% H_2O_2, and several drops of methyl red indicator.

11.0 QUALITY ASSURANCE/QUALITY CONTROL

Results of this procedure can be verified by implementing the following QA/QC measures:

- Syringe calibration
- Instrument preparation
- Instrument zero, span and calibration
- Quality control sample analysis

Instrument Preparation Procedure

1. Freshly prepared drying tubes are required for proper instrument preparation. To prepare the tubes, tightly pack one end of each tube with glass wool. (Wear hand

guards during this operation.) An average packing thickness of one cm should be enough to support the anhydrous magnesium perchlorate (anhydrone). It is important that the glass wool be tightly packed, but it is also important that air can flow through the tube.

2. After all of the tubes have been corked, anhydrone should be carefully poured into the tubes. Granular anhydrone is the best substance to use. Powdered anhydrone can be used in emergencies. Six cm average tube packing should be sufficient. Do not pack the anhydrone into the tube, but allow it to flow in, and do not shake the tube during the process in an effort to pack the anhydrone. When completed, stuff another piece of glass wool into the tube end. After the tubes have been packed, they should be returned to the glass jar to protect them from atmospheric moisture. Tubes can be prepared in advance and stored in an oven (not over 80°C).

3. Insert the freshly prepared drying tubes filled with anhydrous magnesium perchlorate into the instrument.

4. Turn on and warm up the analyzer and recorder for at least 4 hours. It is preferable that the analyzer's main power switch be turned on the night before it is to be used. This will allow the analyzer to achieve thermal equilibrium and for background interference from the electronics to be at a minimum. Check that the compressed air and nitrogen tanks are attached to the proper connections on the Gas Carrier System.

Instrument Zero, Span And Calibration Procedure

Zero

1. After the analyzer has warmed up for at least four hours, adjust the gas regulators to 20 psi (nitrogen and air).

2. Place the injection ampule (acid pool reactor) containing 3 mL working acid solution in the instrument assembly and check for a snug fitting around the rubber gas seals.

3. Place two-way valve in "out-to-analyze" position (IR by "Out" pass).

4. Open the ZERO gas toggle valve.

5. Open the FLOW toggle valve.

6. Adjust the IR rate valve to give a rotameter reading of 12 (N_2).

7. Allow the system to flush.

8. Set the instrument meter at zero with the zero control and lock it into position.

9. Set recorder pen to zero and adjust until integrator is lined out (not counting).

Span

10. Set the instrument span to 800.

11. Recheck the zero at the lowest attenuation (one), and if necessary, adjust the base line to zero (leaving the recorder at an attenuation of one).

12. Inject 200 µL of standard (100 mg/L carbonate solution prepared as described in Section 10). The resulting peak height should be 60 ±5% of full scale. If not, repeat the procedure. (If it is not possible to obtain a satisfactory response, refer to the instrument manual for the optical balance adjustment procedure.)

13. Inject 200 µL of standard carbonate solution several more times. Adjust the zero control on the integrator between injections until the response stabilizes and the integrator stops counting when the pen returns to zero.

Instrument Calibration

14. Analyze the standards according to the procedure outlined under analyses of standards and samples in Section 13.

15. Prepare a calibration curve based on the results of the standards analysis. The curve is a plot of carbonate concentration versus instrument response. The calibration curve is generated using response data from analysis of the blanks and calibration standards. The method of least squares fit of data is used to calculate the slope, y-intercept and correlation coefficient of the calibration curve. The validity of the resulting curve is assessed by examining these three items. The slope of the curve is related to sensitivity. Any marked deviation from the average slope for the method indicates that a change in sensitivity has occurred. The y-intercept of the curve should ideally be equal to zero, i.e., instrument response

to a blank should be zero and the calibration curve should pass through the origin. In practice, the curve rarely passes exactly through the origin. The correlation coefficient indicates the amount of scatter of points around the curve. The instrument response should be directly proportional to the carbonate concentration. Perfect correlation of the x and y data points is indicated by a correlation coefficient of 1.0. An acceptable calibration curve should have a correlation coefficient of no less than 0.9950. A recalibration is required for correlation coefficients less than 0.9950.

Syringe Operation And Calibration Procedure

The first step in calibrating a high precision syringe is to become familiar with proper care and filling procedures. The following steps outline these procedures.

1. Rinse the exterior of the syringe with deionized water and dry it completely.

2. Check the glass casing for cracks and chips. If the casing is cracked, it must be replaced.

3. Make sure that the needle is not blocked.

4. Check the adjustment lock ring. It should be finger tight only.

5. Set the syringe at maximum volume, draw deionized water in slowly and eject it slowly. This should be done 7 to 10 times.

6. After rinsing the syringe with deionized water the sample or standard is slowly drawn in by pulling the plunger back to its maximum distance, discarding the liquid and repeating this step 2 times.

7. The aliquot of sample or standard to be analyzed is slowly drawn with the syringe taking care that no bubbles appear in the liquid.

8. Wipe the needle with a clean dry tissue before injecting the solution to be analyzed into an ampule.

The high precision syringe should be calibrated weekly at the 25, 50, 100 and 200 µL settings using deionized water whose density and temperature are recorded. The specified volumes are injected into a standardization vial and the amount injected is weighed using an analytical balance. Determine the average weight of 5 to 7 injections at each position of the syringe (to the nearest 0.0001 g). Calculate the actual volume of the syringe at each setting using the equation:

$$V_{act} = \frac{W_{avg}}{D_t}$$

where: V_{act} = actual volume of syringe (mL),

W_{avg} = average weight of the water injected (g), and

D_t = density of water at the temperature recorded (g/mL).

The data recording form shown in Figure 1 can be used for syringe calibration.

Quality Control Samples

Quality control samples should be analyzed with the frequencies indicated below.

Analyst: ______________________ **Water Temperature:** $t = 24°C$

Date: ______________________ D_t **= Density of Water at** $t = 0.9973$ **g/mL**

Replicate	Weight of Water (g) Contained in Syringe at Setting			
	25 µL	50 µL	100 µL	200 µL
1	.0287	.0531	.1008	.1986
2	.0283	.0528	.1019	.2002
3	.0285	.0535	.1020	.1993
4	.0288	.0529	.1015	.1989
5	.0281	.0530	.1016	.1996
6	.0284	.0532	.1013	.1995
7	.0285	.0531	.1017	.1995
____________				
W_{avg} (g)	.0285	.0531	.1015	.1993
$\frac{W_{avg}}{D_t} = V_{actual}$ (mL)	.0284	.0530	.1012	.1988

Figure 1. Syringe Calibration Data Recording Form with Example Data.

No. of Samples	No. of Full Sets of Standards	No. of Mid-Range Standards	No. of Duplicate Analyses	No. of Blanks	No. of QC Standards	No. of Sample Spikes
1-10	2	1	2	1	1	1
11-20	3	2	3	1	1	2
21-40	3	2	4	2	2	3
40+	3	<10%	<10%	2	2	3

12.0 SAMPLE ACQUISITION AND HANDLING

Samples collected from an FGD system can be unstable (supersaturated) and can contain volatile compounds (carbonate and sulfite). To stabilize the sample, the liquid and solid phases should be separated with a filtration apparatus. The liquid portion should be properly preserved while the solid portion should be dissolved. Procedures for preserving liquid samples and dissolving/preserving solid samples for analysis are outlined below.

Solid Sample Preparation Procedure

1. Wash scrubber solids collected on filter with a 50% acetone/water mixture and dry in a 50-60°C oven. Limestone samples also should be dried, and a higher temperature (90°C) can be used to speed drying because there is no danger of loss of waters of hydration as there is with scrubber solids.

2. Prepare 40 mL disposable septum sample bottles by affixing labels large enough to contain a sample identification and 3 weight figures. Weigh the dry clean bottles to the nearest 0.01 g and record this as "bottle weight" on the label (W_1) and the data recording form.

3. Weigh an amount of solid sample sufficient to contain 2-10 mg CO_3 to the nearest 0.0001 g and transfer the sample to the sample bottle, recording the weight as "sample weight" (SW) in milligrams.

4. Add 25 mL CO_2-free deionized water (prepared by boiling for 10-15 minutes and sealing with an ascarite absorption tube to ventilate while cooling), and tightly seal the sample bottle.

5. Using a 25 mL syringe, evacuate air from the bottle through the septum.

6. Inject 2-3 mL of 1 N HCl into the sample bottle. Allow one hour for the sample to digest and dissolve. Shake the sample occasionally. [Or use a shaker table or other device to agitate samples in large numbers or place sample bottles (especially if they contain coarse or lumpy solids) in an ultrasonic bath until the solids dissolve or disperse finely.] Remove and cool the sample bottles.

7. Inject 3-5 mL of fresh buffer preservative solution into each sample bottle. Invert and shake several times over a period of 1 hour.

8. Using a 25 mL syringe, fill each bottle to the shoulder of the sample bottle with CO_2-free deionized water. (This step is optional.)

9. Shake the sample bottle thoroughly, weigh it to the nearest 0.01 g, and record this weight as the weight of sample bottle plus sample (W_2).

10. Allow all undissolved solids to settle before removing the sample aliquots with a µL syringe. This will prevent damage to the teflon plunger or cylinder walls of the syringe.

11. Determine the specific gravity, S_3, of the solution containing the dissolved solid sample using the method given in this handbook and record (Figure 2a).

12. Use the worksheet in Figure 2 to calculate the dissolution/dilution factor, DF, according to the following equation:

$$DF = \frac{W_2 - W_1}{SW \times S_3}$$

where: DF = dilution/dissolution factor for dissolved solid samples; mL solution/mg sample,

W_2 = weight of sample bottle plus dissolved solid sample from step 9(g),

W_1 = weight of sample bottle from step 2(g),

SW = solid sample weight from step 3 (g), and

S_3 = specific gravity of dissolved solid solution from step 11.

Liquid Sample Preparation Procedure

1. Determine the specific gravity of the liquor sample and the buffer preservative solution using the method described in this handbook. Record these values on the dilution factor worksheet (Figure 2b).

2. Label a clean and dry sample bottle (30 or 50 mL polyethylene or polypropylene bottle), cap the bottle, and weigh to the nearest 0.01 g. Record the weight (W_1) on the sample label and on the data recording form (Figure 2).

Analyst: ______________________

Date: ______________________

S_g = Specific gravity of dissolved solid sample _____ g/mL

Sample ID	W_2 Weight of Sample Bottle plus Dissolved Sample (g)	W_1 Weight of Sample Bottle (g)	SW Weight of Solid Sample (mg)	$DF = \frac{W_2 - W_1}{S_g \cdot SW}$

Figure 2a. Worksheet for Calculating Dissolution/Dilution Factor for Solid Samples.

Analyst: ______________________

Date: ______________________

S_2 = Specific gravity of liquor sample ______ g/mL

S_1 = Specific gravity of buffer preservative ______ g/mL

Sample ID	W_1 Weight of Sample Bottle (g)	W_2 Weight of Sample Bottle plus Preservative (g)	W_3 Weight of Bottle, Preservative and Sample (g)	$A = \frac{W_3 - W_2}{S_2}$	$B = \frac{W_2 - W_1}{S_1}$	$DF = \frac{A - B}{A}$
001						

Figure 2b. Worksheet for Calculating Dilution Factor for Liquor Samples.

3. Accurately pipet 5.00 mL of buffer solution into the sample bottle and cap the bottle immediately.

4. Weigh the contents and the bottle to the nearest 0.01 g and record the weight (W_2) on the sample label and the data recording form.

5. Fill the sample bottle to the top with sample, but do not overflow. Cap the bottle and mix thoroughly.

6. Weigh the contents and the bottle to the nearest 0.01 g and record the weight (W_3) on the sample label and on the data recording form.

7. Use the worksheet in Figure 2 to calculate a dilution factor for preserved liquid samples. This factor is used to correct the analytical results. It is calculated using the following equation:

$$DF = \frac{\dfrac{W_3 - W_2}{S_2} + \dfrac{W_2 - W_1}{S_1}}{\dfrac{W_3 - W_2}{S_2}}$$

where: DF = dilution factor (dimensionless),

W_1 = weight of empty sample bottle (g),

W_2 = weight of sample container and preservation solution (g),

W_3 = weight of sample container, buffer preservation solution, and sample (g),

S_1 = specific gravity of buffer preservation solution (g/mL), and

S_2 = specific gravity of the sample (g/mL).

8. Prepare a reagent blank as outlined in steps 1-6 except substitute deionized water for the sample.

13.0 STEPWISE PROCEDURE

Standard and Sample Analysis

1. Make zero and span adjustments according to the procedure outlined in Section 11.

2. Place the two-way valve in the "out-to-analyze" position.

3. Place or replace the injection ampule containing 3 mL working acid solution in the ampule-breaking assembly.

4. Lower the flushing tube well below the acid level.

5. Purge the system with zero gas (N_2) until the instrument has returned to zero.

6. Raise the flushing tube above the acid level.

7. Inject the standard into the acid pool.

8. Lower the flushing tube below the acid level.

9. Check for a flow rate of 12 (N_2).

10. The recorder should show the peak height and integration. Label the peak and record the integration count.

11. Repeat steps 6-10 with: blank and 25, 50, 100, and 200 µL of 100 mg/L carbonate standard.

12. Prepare a calibration curve as described in Section 11 Step 15 and Section 15, Steps 1 and 2.

13. Once an acceptable calibration curve has been prepared, repeat steps 6-10 with the samples. The sample volume injected should give a count near the middle or upper portion of the calibration curve. If it does not, repeat the injection with a smaller volume of sample.

14. Inject standards, QC samples, spikes, and duplicates between samples with the frequency called for in Section 11 (Quality Control).

15. After all samples have been analyzed, turn off all equipment. If samples are to be analyzed the next day, leave the main power source on.

14.0 DATA RECORDING FORM

Figures 1, 2a, 2b, 3 and 4 present example data recording forms.

15.0 CALCULATIONS

1. Prepare a calibration curve showing the relationship between instrument response (peak area) and carbonate concentration in the standards. First, calculate the amount of carbonate, C_{INJ}, in each injection of standard carbonate solution:

$$C_{INJ} = C_{STD} \times V_{ACT}$$

where: C_{INJ} = weight of carbonate injected, µg;
C_{STD} = concentration of carbonate in standard solution, µg/mL;
V_{ACT} = corrected volume of injected solution at syringe setting (from Figure 1), mL.

2. Record the weight of carbonate in each standard injected in an instrument calibration data table like the one shown

Analyst: ____________________ Date Syringe Calibrated ______________

Date Standards Analyzed: ____________________

Standard No.	Syringe Setting (µL)	V_{ACT} (mL)	C_{STD} (µg/mL)	C_{INJ} µg Carbonate Injected	Peak Area (integrator counts)
1	100	0.1028	50	5.14	5000.
2	200	0.2015	50	10.08	10000
Blank	150		0	0	100

---

m (slope of calibration line) _________

b (y-intercept of calibration line) _________

C_{INJ} = (peak area) - b/m

Figure 3. Instrument Calibration Data Recording Form with Example Data.

Analyst: ____________________

Date: ____________________

Sample ID	Syringe Setting	V_{ACT} mL (Fig. 1)	Peak Area (Integrator Counts)	C_{INJ} µg Carbonate (Fig. 3)	DF Dilution Factor (Fig. 2a)	C µg/mL or µg/mg

$$C = \frac{C_{INJ}}{V_{ACT}} \times DF$$

Figure 4. Data Recording Form for Calculating Carbonate Concentration.

in Figure 3. Also record the corresponding number of integrator counts or peak area for each injection of standard.

3. Use the data in Figure 3 to describe the linear relationship between peak area (Y) and the mg carbonate injected (X). Either plot the data on linear graph paper and use a straightedge to draw the straight line that comes closest to all the data points, or calculate the slope (m) and y-intercept (b) of the line using the method of least squares (Refer to volume I of handbook).

4. Determine the weight of carbonate injected in a sample from the sample peak area (number of integrator counts) and the calibration data (Figure 3). If the calibration line was plotted on a graph with µg carbonate on the x-axis and integrator counts on the y-axis, use the graph to find the weight of carbonate in the sample. Find the number of integration counts for the sample on the y-axis, move horizontally until the calibration line is intersected, then move vertically to find the corresponding value of µg carbonate on the x-axis. Or, if the method of least squares was used, calculate the weight of carbonate injected in a sample from the slope (m) and intercept (b) of the calibration line:

$$C_{INJ} = \frac{(\text{No. of integrator counts}) - b}{m}$$

Record the Sample ID, syringe setting, weight of carbonate injected, C_{INJ}, and the number of integrator counts on the data recording form (Figure 4 for liquids or for solids).

5. Obtain the actual volume of sample injected (V_{ACT}) for the syringe setting from Figure 1 and the dilution factor (DF) for the sample ID from Figure 2a or 2b and record the values on the data recording form (Figure 4).

6. Calculate carbonate concentration in the original (undiluted) liquor or solid sample with the following equation:

$$C_L = \frac{C_{INJ}}{V_{ACT}} \times DF$$

where: C_L = carbonate concentration in solid sample (µg/mg or mg/g), or liquor sample (µg/mL or mg/L),

C_{INJ} = weight of carbonate in injected sample (µg),

V_{ACT} = volume injected at syringe setting (mL), and

DF = dilution factor from Figure 2a or 2b, in mL/mg for solids or dimensionless for liquid samples.

7. Use the following conversion factors to express results in terms of calcium carbonate or carbon dioxide instead of carbonate.

mg/L carbonate x 0.73 = mg/L carbon dioxide
x 1.67 = mg/L calcium carbonate

mg/g carbonate ÷ 10 = wt% carbonate
x 0.73 = mg/g carbon dioxide
x 1.67 = mg/g calcium carbonate

16.0 PRECISION AND BIAS

The precision and bias of carbonate analysis by NDIR absorption spectrophotometry have been investigated (Refer to volume I of handbook). The procedure given in Sections 12 and 13 was used to analyze five synthetic scrubber liquors, four limestones, and two sludge samples from lime FGD systems. The linear least squares curve fit technique was used to prepare calibration curves. Solid samples were digested for one hour.

Table 2 gives the results of determination of single operator precision and bias for carbonate analyses. The results of analysis are expressed as mg carbonate per liter for synthetic liquors and mg carbonate per gram for limestone and sludges.

The pooled coefficient of variation for synthetic liquor samples containing calcium, magnesium, sodium, sulfate, chloride, and 6 to 36,000 mg/L carbonate was 4.0 percent. The range of bias based on known amounts of carbonate added was -16 to 39 percent, although significant bias was not found for the sodium carbonate sample or the magnesia scrubbing liquor.

The pooled coefficient of variation for one reagent grade calcium carbonate sample and four limestone samples was 5.3 percent; percent bias ranged from -6. to 3.9 percent. No significant bias was found for any of the four limestones. The pooled coefficient of variation for solid samples from lime FGD systems was 8.4 percent.

Table 3 summarizes the precision limits for carbonate analysis on the three materials tested. The single-operator coefficient of variation (one sigma limit) and the difference two sigma limit are given. The results of two properly conducted analyses by the same analyst on the same material using the same instrument should not differ by more than the percent of their average shown in the last column of Table 3.

17.0 REFERENCES

1. J.W. Molina. Aqueous CO_2 - Oceanography CO_2 Analyzer. Radian Corporation Technical Note 200-403-50, 1973.

Table 2

RESULTS OF INVESTIGATION OF PRECISION AND BIAS OF CARBONATE ANALYSIS IN SCRUBBER LIQUOR, SOLIDS AND LIMESTONE BY NDIR SPECTROPHOTOMETRY

Sample ID and Description[1]	True Value[2] (mg/L or mg/g)	n = number of Replicates[3]	Mean of Measurements (mg/L or mg/g)	Precision[4] Standard Deviation (mg/L or mg/g)	Precision[4] Coefficient of Variation (%)	Bias[5] (%)
Synthetic Liquid Samples						
QCCG-Na_2CO_3 in deionized water	100.	6	102.2	4.1	4.1	2.2*
LQ5-High TDS limestone scrubber liquor	6.0	3	8.32	0.5	6.0	39.
LQ1-High magnesium lime scrubber liquor	30.	8	31.	1.1	3.4	3.2*
LQ2-Magnesia (high Mg) scrubber liquor	120.	8	157.	6.6	4.2	31.
LQ4-Low TDS limestone scrubber liquor	300.	8	262.	5.5	2.1	-13.
LQ3-Dual alkali scrubber liquor	36,000.	8	30,300.	1,040.	3.4	-16.
Solid Samples						
Reagent grade calcium carbonate	600.	6	575.	35.3	6.1	-4.1*
LS-1 Monteagle limestone	550.	6	550.	44.	7.9	0*
LS-2 Cilco limestone	572.	5	591.	17.	2.9	3.3*
LS-3 Brassfield limestone	576.	7	599.	23.	3.8	3.9*
LS-4 NBS dolomite	636.	7	595.	30.	5.0	-6.4*
SL1-Lime spray dryer product (80% fly ash)		8	12.0	0.7	6.0	NA
SL1-Lime scrubber solids		8	15.4	1.6	10.3	NA

---

[1]

Sample ID	Composition (mg/L) Ca	Mg	Na	SO_4	CO_3	Cl
LQ1	400	1,215	379	6,144	30	284
LQ2	160	36,500	1,200	146,000	120	285
LQ3	40	122	45,800	48,000	36,000	14,300
LQ4	561	243	643	2,570	300	600
LQ5	20,000	608	237	768	6	35,800

[2] For synthetic liquors, the true value is the known amount of reagent grade chemicals added to deionized water. For limestone samples the true value is based on repeated measurements using a number of different analytical methods.

[3] Number of times a separate sample of the same material was analyzed by the same analyst with the same instrument and a separate calibration

[4] Standard deviation = $[\Sigma(X_i - \bar{X})^2/n-1]^{1/2}$

Coefficient of variation = (standard deviation/mean) x 100

[5] Bias = [(mean - true value)/true value] x 100

* Not statistically significant at the 0.95 level of confidence

Table 3

PRECISION LIMITS FOR ANALYSIS OF CARBONATE IN LIMESTONE AND SCRUBBER LIQUORS AND SOLIDS BY NDIR ABSORPTION SPECTROPHOTOMETRY

Material	Single Operator Coefficient of Variation* (1S%)	Difference Two Sigma Limit* (D2S%)
Synthetic scrubber liquors containing 6 to 36,000 mg/L carbonate as well as Ca, Mg, Na, SO_4 and Cl	4.0	11.3
Limestone	5.3	15.0
Solids from lime FGD systems	8.4	23.8

---

*These numbers represent, respectively, the (1S%) and (D2S%) limits described in ASTM Practice C670-81 for preparing precision statements for test methods for construction materials.

2. S. A. Schubert and K. L. Kelly. Demonstration of Adipic Acid Addition on a Full-Scale Operating Limestone FGD System--Analytical Procedures Manual for City Utilities of Springfield Southwest Power Plant. Radian Corporation DCN 80-213-012-11, prepared for the U.S. EPA, November 1980.

3. K. Schwitzgebel, et. al. Development of Sampling and Analytical Methods of Lime/Limestone Wet Scrubbing Tests. Vol. I&II. Final Report OAP Contract No. CPA TO-143, Radian Project No. 200-006, 1971.

4. B. F. Jones, et. al. Experimental and Theoretical Studies of Solid Solution Formation in Lime and Limestone SO_2 Scrubbers. Vol. II, Appendices. Radian Corporation, EPA 600/2-76-2736, October 1976.

5. Laboratory Procedures Manual. Shawnee Test Facility. Prepared by Bechtel National, March 1976.

6. C. Galloway and P. Nassos. Radian Laboratory Notebook No. 00645. October 1982.